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CONTENTS

ORIGINAL ARTICLES

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An Object Detection Method Using Invariant Feature Based on Local Hue Histogram in Divided Areas of an Object

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ABSTRACT

In recent years, the decreasing birthrate and aging population are developing, and there is concern about the lack of labor power such as household chores and nursing care at home. Therefore, application of robot technology to the living field is expected. In the living field, Robots that support the lives of people are collectively referred to as life support robots. This robot is required to perform various tasks to support humans. Especially, the object detection task is important when people request the robot to transport and rearrange objects. However, when detecting an object from the camera mounted on the robot, detection becomes difficult because the detection environment is unspecified. Scale Invariant Feature Transform (SIFT) and Color Indexing are widely known as object detection methods using two-dimensional information. However, these methods do not have robustness against all environmental changes. In this research, we focus on the invariant feature of the hue histogram in divided areas of an object and propose a highly accurate object detection method.

KEYWORDS

Life support robot, Cognitive system, Hue histogram, Position of peak and trough, divided areas.

1 INTRODUCTION

In recent years, the decreasing birthrate and aging population are developing, and there is concern about the lack of labor power such as household chores and nursing care at home. Therefore, application of robot technology to the living field is expected. In the living field, robots that support the lives of people are collectively referred to as life support robots [1][2][3]. This robot is required to perform various tasks to support humans. Especially, the object detection task is important when people request the robot to transport and rearrange objects.

(a) A target object (b) An input image

Figure. 1. An example of input data in object detection.

The object detection is technology to detect a target object (Fig. 1 (a)) from an input image (Fig. 1 (b)).

There is a problem which the detection becomes difficult when detecting a target object from the camera mounted on the robot, because differences of visual appearance occur such as the rotation change. Therefore, we consider that there are six necessary properties to detect in domestic environment as follows.

1. Robustness against the rotation change
2. Robustness against the scale change
3. Robustness against the illumination change
4. Robustness against the distortion by perspective projection
5. Robustness against the occlusion
6. Detecting an object which has few textures

Firstly, the robots need the robust detection for the rotation change because the rotation change is occurred in case that an object falls down such as Fig. 1 (b). Secondly, the robots need the robust

detection for the scale change because the scale change is occurred by the position between the robots and an object. Thirdly, the robots need the robust detection for the illumination change because the precision of detection is easy to be affected by illumination condition. Fourthly, the robots need the robust detection for the distortion by perspective projection because the distortion by perspective projection is occurred in case that the robot moves sideways, looks up or looks down. Fifthly, the robots need the robust detection for occlusion because occlusion is occurred between different objects. Finally, the robots need to detect an object which has few textures. As an example, Fig. 2 shows an object which has few textures.

As conventional methods, there are the Scale Invariant Feature Transform (SIFT) [4] and the Color Indexing [5]. Table 1 shows properties of these methods.

To detect a target object from an input image, the SIFT compares local feature amount of a target object with local feature amount of an input image, and extracts correspondence points as shown in Fig. 3. Therefore, as shown item 1-3 and 5 in Table 1, the SIFT has robustness against the rotation change, the scale change, the illumination change and occlusion. However, as shown item 4 in Table 1, the SIFT does not have robustness against the distortion by perspective projection that local feature amount

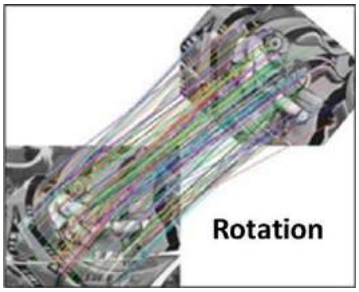


Figure. 3. An example of matching based on the feature of SIFT.

changes. In addition, as shown item 6 in Table 1, the SIFT is difficult to detect an object which has few textures because the SIFT cannot detect feature amount from objects such as shown in Fig. 2 which have few textures.

On the other hand, Swain et al. proposed the Color Indexing. To detect a target object from an input image, the Color Indexing compares three dimensional color histogram of a target object with three dimensional color histogram of a candidate object. As an example, Fig. 4 shows three dimensional color histogram. As shown in Fig. 4, a size of the square in three dimensional color histogram expresses the frequency of each color. The frequency of each color does not change in case that the rotation change, the scale change, the distortion by perspective projection and occlusion are occurred. In addition, the Color Indexing can

Figure. 2. An example of an object with few textures.

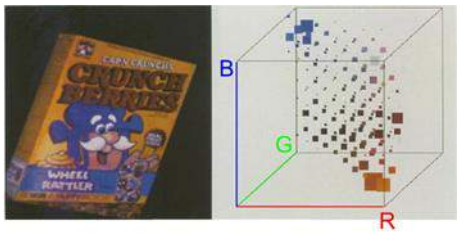


Figure. 4. An example of a three-dimensional color histogram.

Table 1. Properties of conventional methods and the proposed method.

	1. Rotation change	2. Scale change	3. Illumination change	4. Distortion by perspective projection	5. Occlusion	6. An object which has few textures	7. Different objects which have same features of histogram
SIFT	○	○	○	×	○	×	○
Color indexing	○	○	×	○	○	○	○
Tanaka's method	○	○	○	○	○	○	×
Our proposed method	○	○	○	○	○	○	○

detect an object which has few textures by using the color information. Therefore, as shown item 1, 2 and 4-6 in Table 1, the Color Indexing has robustness against the rotation change, the scale change, distortion by perspective projection, occlusion and an object which has few textures. However, as shown item 3 in Table 1, the Color Indexing is difficult to detect in case that illumination is changed, because the Color Indexing uses RGB color system which is easy to be affected by the illumination change.

Tanaka et al. [6] focused on hue. Hue has three merits. Firstly, hue is hardly affected by illumination and shadow. Secondly, hue is invariable against the distortion by perspective projection. Finally, the detection using hue can detect an object which has few textures. In addition, as shown in Fig. 5, the positions of peak and trough of the hue histogram is invariable against the rotation change, the scale change, the illumination change, the distortion by perspective projection and occlusion. In Fig. 5, we define the longitudinal axis as the frequency, and the lateral axis as the hue value. In addition, the circle indicates the position of peak and the square indicates the position of trough. Accordingly, Tanaka et al. proposed the object detection method using invariant feature based on the hue histogram. To detect a target object from an input image, this method extracts the positions of peak and trough of the hue histogram as invariant feature. In addition, this method compares invariant feature of a target object with invariant feature of a candidate object. As mentioned above, the positions of peak and trough of the hue histogram do not change in case that the rotation change, the scale change, the illumination change, the distortion by perspective projection and occlusion are occurred. In addition, this method can detect an object which has few textures by using hue information. Therefore, as shown item 1-6 in Table1, this method has robustness against the rotation change, the scale change, the illumination change, the distortion by perspective projection, occlusion and an object which has few textures. However, this method does not satisfy a property as follows.

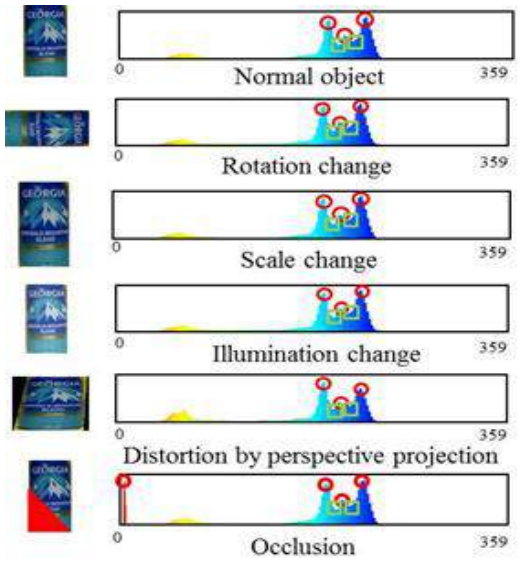


Figure. 5. The invariance of the position of the unevenness of the hue histogram for each change.

7. Distinguishing different objects which have the same features of the hue histogram

This method cannot distinguish objects which have the different textures but have the same positions of peak and trough of the hue histogram. As an example, Fig. 6 (a), (b) shows different objects which have the same features of the hue histogram. Fig. 6 (c), (d) shows the hue histogram of Fig. 6 (a), (b) respectively. As shown item 7 in Table 1, this method cannot distinguish objects (Fig. 6 (a), (b)) as different object because the positions of peak and trough of Fig. 6 (a) equal the positions of peak and trough of Fig. 6 (b) as shown in Fig. 6 (c), (d). As mentioned above, as shown in Table 1, the SIFT, the Color Indexing and this method do not satisfy all seven properties.

Therefore, to satisfy the seven properties for detection, we propose an object detection method using invariant feature based on the local hue histogram in divided areas of an object instead of invariant feature based on the hue histogram in the

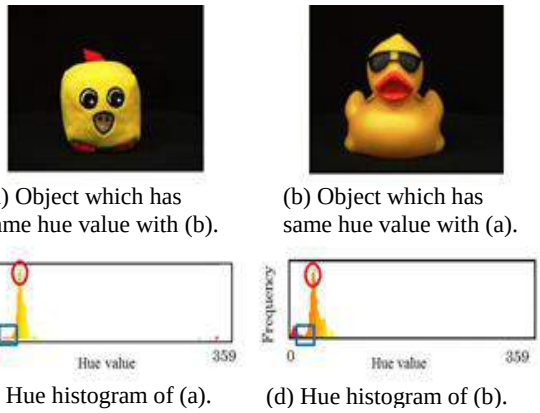
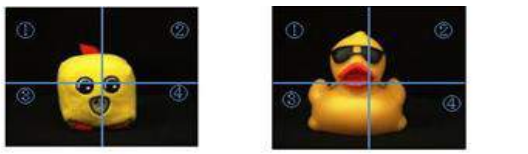
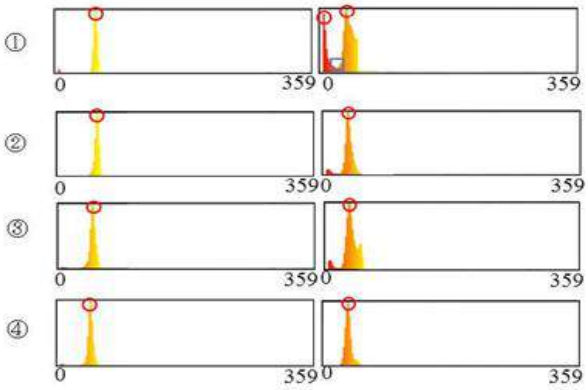


Figure. 6. An example of different objects with a similar hue value.



(a) Divided area of Fig. 6 (a). (b) Divided area of Fig. 6 (b).



(c) Local hue histograms of each divided area of Fig.7 (a). (d) Local hue histograms of each divided area of Fig.7 (b).

Figure. 7. An example of local hue histograms in divided areas.

whole object area. As our approaches, firstly, the proposed method divides an object area into plural areas. As an example, Fig. 7 (a), (b) shows divided objects. Secondly, the proposed method extracts hue from each divided area and generates local hue histograms. As an example, Fig. 7 (c), (d) shows the local hue histograms of Fig. 7 (a), (b). Thirdly, the proposed method extracts the positions of peak and trough from each local hue histogram as invariant feature. As shown in Fig. 7 (c), (d), the positions of peak and trough of the local hue histogram changes for each divided area by dividing an object area. Finally, the proposed method compares invariant feature of the target object with invariant feature of the candidate object every each local hue histograms. Thereby, the proposed method can distinguish different objects which have the same feature of hue histogram. Furthermore, the proposed method has robustness against the rotation change, the scale change, the illumination change, the distortion by perspective projection, occlusion and an object which has few textures as shown in Table 1.

2 PROPOSED METHOD

2.1 Flow of Proposed Method

We show the flow of the proposed method in fig.8. We represent each processing in the next sections.

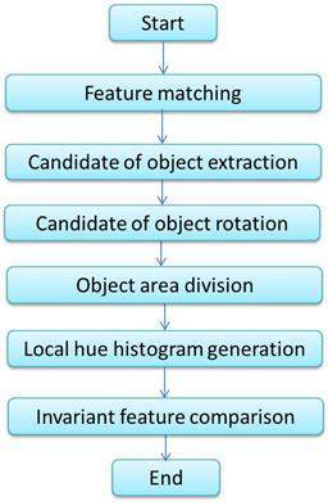


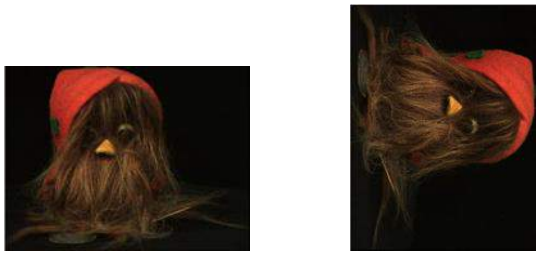
Figure. 8. Flow of the proposed method.

2.2 Feature Matching

Firstly, the proposed method extracts feature points from the registered image (Fig. 9 (a)) and the input image (Fig. 9 (b)) based on the feature of the BRISK [7]. As an example, we set the registered image which rotated 90 degrees to the input image in this time. Finally, the proposed method performs matching based on the BRISK descriptor between the registered image and the input image.

2.3 Candidate of Object Extraction

Firstly, as shown in Fig. 10, the proposed method calculates a vector **A** from the most matched feature point of BRISK to the most far away endpoint on the object area in the registered image, and defines a norm of vector **A** as the maximum distance dm. Secondly, the proposed method calculates vector **R** from the most matched feature point of BRISK to the second most matched feature point of BRISK in the registered image and vector **I** from the most matched feature point of BRISK to the second most matched feature point of BRISK in the input image, and calculates the ratio of the size of the registered image to the size of the input image by using



(a) Registered image. (b) Input image.

Figure. 9. Sample data for overview.

(a) Registered image. (b) Input image.

Figure. 10. Candidate area extraction.

$$r = \|\mathbf{R}\| / \|\mathbf{I}\| \quad (1)$$

Where r is the ratio, $\|\mathbf{R}\|$ is the norm of vector **R**, $\|\mathbf{I}\|$ is the norm of vector **I**. Thirdly, the proposed method describes a circle with the center is the most matched feature point of BRISK and radius is $\|\mathbf{A}\|$ in the registered image. In addition, the proposed method describes a circle with the center is the most matched feature point of BRISK and radius is $\|\mathbf{B}\|$ in the input image. Vector **B** is calculated by using

$$\mathbf{B} = \mathbf{A} / r \quad (2)$$

Where **B** is vector **B**, **A** is vector **A**, r is the calculated ratio. Fourthly, the proposed method extracts the contour of the circle in the registered image and the input image. Finally, the proposed method trims the registered image and the input image with in the extracted contours. Thereby, it is possible to accurately extract the candidate area even when scale is different or occlusion occurs as shown in Fig. 10.

2.4 Candidate Object Rotation

As shown in Fig. 11, in case that the input image rotates, the feature amount of the hue histogram in the same region changes. Therefore, it is necessary to rotate the input image. Firstly, the proposed method extracts feature points from the trimmed registered image and the trimmed input image, and performs matching based on the BRISK descriptor between the trimmed registered image and the trimmed input image. Secondly, since the proposed method rotates the trimmed input image, it is necessary to calculate a homography matrix describing the relationship between corresponding points as shown in equation (3).

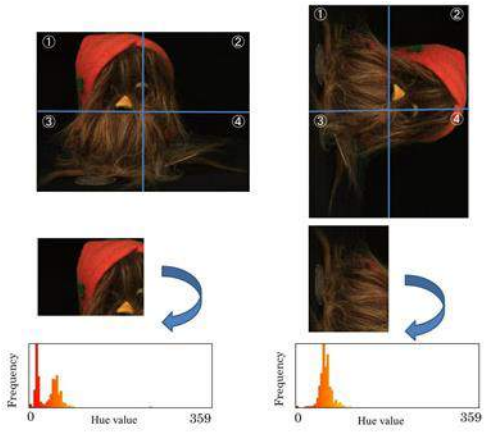


Figure. 11. An example of a case that the target object in the input image is rotating.

$$\begin{pmatrix} sx_2 \\ sy_2 \\ s \end{pmatrix} = H \begin{pmatrix} x_1 \\ y_1 \\ 1 \end{pmatrix} = \begin{pmatrix} h_{11} & h_{12} & h_{13} \\ h_{21} & h_{22} & h_{23} \\ h_{31} & h_{32} & h_{33} \end{pmatrix} \begin{pmatrix} x_1 \\ y_1 \\ 1 \end{pmatrix}, \quad (3)$$

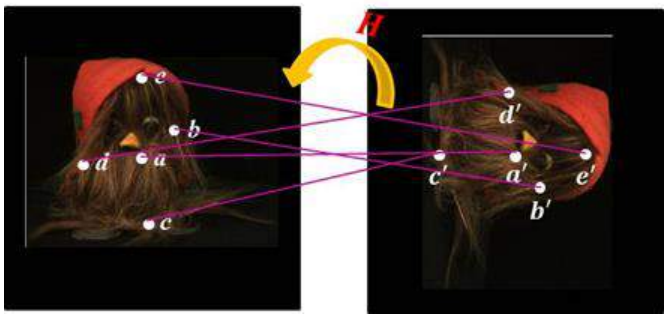
Where H is the homography matrix, (x_1, y_1) are the coordinates before the rotation, (x_2, y_2) are the coordinates after the rotation, s is a coefficient. Therefore, the proposed method calculates a homography matrix by using Direct Linear Transform algorithm. Finally, the proposed method rotates the trimmed input image by calculated the homography matrix as shown in Fig. 12.

2.5 Object Area Division

To generate the local hue histogram, the proposed method divides the trimmed registered image and the rotated input image into plural areas. Here, we define the number of division as four as an example.

2.6 Local Hue Histogram Generation

Firstly, the proposed method extracts hue from each divided area and generates local hue histograms. The hue value of the generated histogram is represented from 0 to 359. Fig. 13 shows the divided areas and local hue histograms. We define the vertical axis as the frequency, and the horizontal axis as the hue value. Here, we pay attention to item ① of Fig. 13. Fig. 14 (a) shows an



(a) Registered image. (b) Input image.

Figure. 12. Rotation processing.

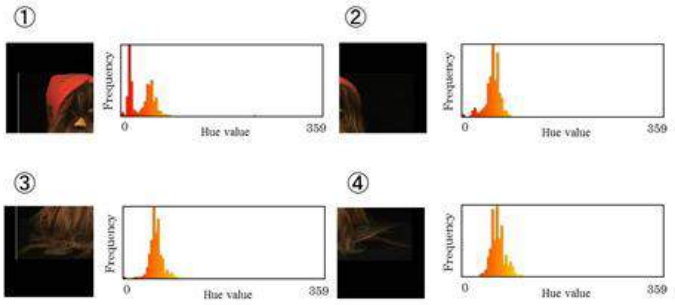
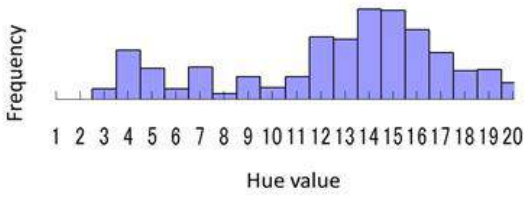


Figure. 13. An example of divided areas and local hue histograms.

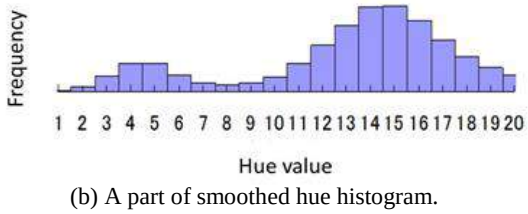
expanded hue histogram of item ① of Fig. 13. In Fig. 14 (a), because there are small irregularities at 7 and 9 of hue value, the feature amount becomes unstable by detecting the positions of peak and trough of the hue histogram in this state. Secondly, to eliminate those small irregularities, the proposed method smooths the hue histogram by using Gaussian filter. Fig. 14 (b) shows a smoothed hue histogram of Fig. 14 (a). In Fig. 14 (b), we can see that small irregularities of the hue histogram are omitted and the characteristic positions of peak and trough of the hue histogram are remained. Finally, the proposed method extracts the positions of peak of the smoothed hue histogram from each divided areas of the registered image and the input image by using

$$(H_{x-1} < H_x) \wedge (H_x > H_{x+1}), \quad (4)$$

and the positions of trough of the smoothed hue histogram from each divided areas of the registered image and the input image by using



(a) A part of hue histogram.



(b) A part of smoothed hue histogram.

Figure. 14. Smoothing processing.

$$(H_{x-1} > H_x) \wedge (H_x < H_{x+1}), \quad (5)$$

and registers them as invariant feature. Where H_x is the hue value which is focused on, H_{x-1} is the hue value before one of H_x. H_{x+1} is the hue value after one of H_x. And then, the extracted positions of peak and trough of the registered image are expressed by using

$$\left\{{p_1}_{(a)}{}^{(\alpha)}, {p_2}_{(a)}{}^{(\alpha)}, \cdots\right\} \in {P_{(a)}}^{(\alpha)}, \quad (6)$$

$$\left\{{t_1}_{(a)}{}^{(\alpha)}, {t_2}_{(a)}{}^{(\alpha)}, \cdots\right\} \in {T_{(a)}}^{(\alpha)}, \quad (7)$$

Where ${P_{(a)}}^{(\alpha)}$ is a set of peak position of a smoothed hue histogram in a divided area α of a. ${p_1}_{(a)}{}^{(\alpha)}, {p_2}_{(a)}{}^{(\alpha)}, \cdots$ which are each peak positions of a smoothed hue histogram, ${T_{(a)}}^{(\alpha)}$ is a set of trough position of a smoothed hue histogram in a divided area α of a. ${t_1}_{(a)}{}^{(\alpha)}, {t_2}_{(a)}{}^{(\alpha)}, \cdots$ which are each trough positions of a smoothed hue histogram. In addition, the extracted positions of peak and trough of the input image are expressed by using

$$\left\{hp_1{}^{(\beta)}, hp_2{}^{(\beta)}, \cdots\right\} \in hP^{(\beta)}, \quad (8)$$

$$\left\{ht_1{}^{(\beta)}, ht_2{}^{(\beta)}, \cdots\right\} \in hT^{(\beta)}, \quad (9)$$

Where $hP^{(\beta)}$ is a set of peak position of a smoothed hue histogram in a divided area β, $hp_1{}^{(\beta)}, hp_2{}^{(\beta)}, \cdots$ which are each peak positions of a smoothed hue histogram, $hT^{(\beta)}$ is a set of trough position of a smoothed hue histogram in a divided area β, $ht_1{}^{(\beta)}, ht_2{}^{(\beta)}, \cdots$ which are each trough positions of a smoothed hue histogram.

2.7 Invariant feature comparison

Firstly, the proposed method calculates difference values between invariant feature of the registered image and invariant feature of the input image by using

$$Dp_1 = \min_{\substack{1 \le y \le n \\ 1 \le \alpha, \beta \le i \\ 1 \le a \le m}} \left| {p_1}_{(a)}{}^{(\alpha)} - hp_y{}^{(\beta)} \right|, \quad (10)$$

$$Dp_2 = \min_{\substack{1 \le y \le n \\ 1 \le \alpha, \beta \le i \\ 1 \le a \le m}} \left| {p_2}_{(a)}{}^{(\alpha)} - hp_y{}^{(\beta)} \right|, \quad (11)$$

$$\vdots$$

$$Dt_1 = \min_{\substack{1\le z\le l \\ 1\le \alpha,\beta\le i \\ 1\le a\le m}} \left| {t_1}_{(a)}{}^{(\alpha)} - ht_z{}^{(\beta)} \right|, \quad (12)$$

$$Dt_2 = \min_{\substack{1\le z\le l \\ 1\le \alpha,\beta\le i \\ 1\le a\le m}} \left| {t_2}_{(a)}{}^{(\alpha)} - ht_z{}^{(\beta)} \right|, \quad (13)$$

$$\vdots$$

$$DP = \sum_{\alpha=1}^{f} Dp_\alpha, \quad (14)$$

$$DT = \sum_{b=1}^{k} Dt_b, \quad (15)$$

$$D = DP + DT, \quad (16)$$

Where n is the number of peak of a smoothed hue histogram in a divided area β , i is the number of division, m is the number of registered image, l is the number of trough of a smoothed hue histogram in a divided area β . $Dp_1, Dp_2, \cdots$ which are the smallest difference values between $hP^{(\beta)}$ to ${p_1}_{(a)}{}^{(\alpha)}, {p_2}_{(a)}{}^{(\alpha)}, \cdots, {p_1}_{(a)}{}^{(\alpha)}, {p_2}_{(a)}{}^{(\alpha)}, \cdots$ which are each peak positions of a smoothed hue histogram in a divided area α of α, $Dt_1, Dt_2, \cdots$ are the smallest difference values between $hT^{(\beta)}$ to ${t_1}_{(a)}{}^{(\alpha)}, {t_2}_{(a)}{}^{(\alpha)}, \cdots, {t_1}_{(a)}{}^{(\alpha)}, {t_2}_{(a)}{}^{(\alpha)}, \cdots$ which are each trough positions of a smoothed hue histogram in a divided area α of α, f is the number of peak of a smoothed hue histogram in a divided area α of α, k is number of trough of a smoothed hue histogram in a divided area α of α, DP is the total value of difference value of peak position, DT is the total value of difference value of trough position, D is the total difference value. As an example, Fig. 15 shows that the comparison of the hue histogram of a registered image and the hue histogram of an input image. As shown in Fig. 15, the proposed method compares the positions of peak and trough of a smoothed hue histogram of a registered image with the positions of peak and trough of a smoothed hue histogram of an input image, and calculates difference values. In addition, the proposed method registers a peak and a trough having the smallest difference value as the nearest peak and trough. Finally, the proposed method detects the object which has smallest D.

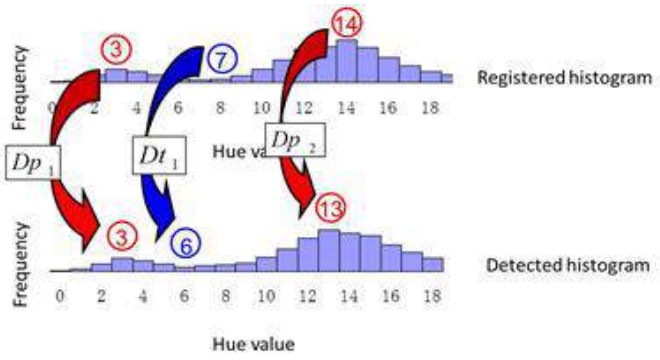


Figure. 15. An example of matching based on the positions of the unevenness of the hue histogram.

3 EXPERIMENT

3.1 Experiment Relating to the Number of Division of an Image

1) Experiment Overview: In this experiment, to determine the optimum number of division, changing the number of division from 1 piece to 25 pieces, the proposed method detected a registered object from an input image. Furthermore, we calculated the correct answer ratio by using

$$A = \frac{c}{z} \times 100\ [\%]\ , \quad (15)$$

and defined the number having the highest correct answer ratio as the number of division. Where A is the correct answer ratio, c is the number which the proposed method could correctly detect objects, z is the number of the registered objects. We selected 5 images in normal object (Fig. 16 (a)), 5 images in object which has few textures (Fig. 16 (b)), and 5 images in object which has same hue value (Fig. 16 (c)), totaling 15 images of objects from Amsterdam Library of Object Images [8] as the test image. In the object which has same hue value, we selected the object which has hue values of yellow and red.

2) Experimental Results: Fig. 17 shows the result of this experiment. As a result, a correct answer ratio increased as number of division increased. In addition, the correct answer ratio became the highest in case that the number of division is four and continued maintaining afterwards. However, we carried out the experiment on occluded objects, because we could not determine the most suitable number of division in this result. Fig. 18 shows the

(a) Normal object. (b) Object with few textures. (c) Object which has same hue value.

Figure. 16. Features of each object.

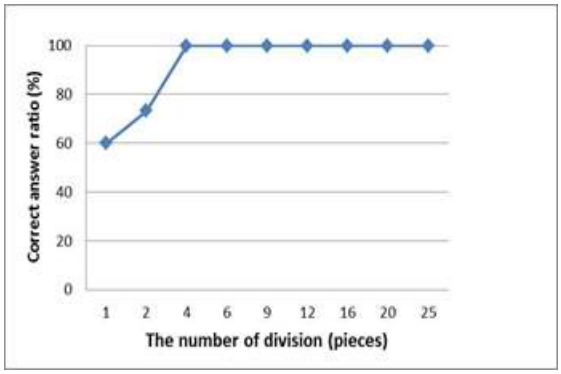


Figure. 17. The correct answer ratio of the experiment for the number of division.

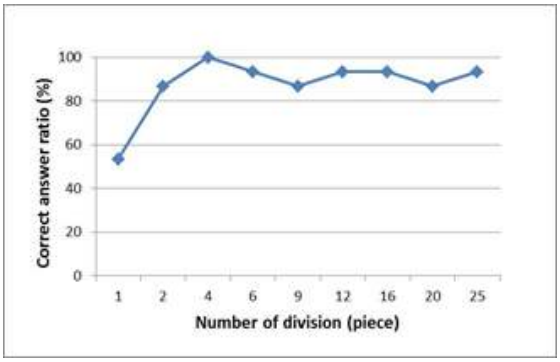


Figure. 18. The correct answer ratio of the experiment for the number of division in occluded objects.

result of the experiment of the occluded objects. As a result, the correct answer ratio became highest in case that the number of division is four. However, the correct answer ratio repeated increase and decrease between 80% and 100%. From these results, we defined the number of division as four pieces in this paper.

3) Discussions: We understood that the optimal number of division was difference according to objects from these experimental results. Therefore, we saw that it is necessary to statistically calculate the optimal parameter to increase the correct answer ratio. We understood that the optimal number of division was difference according to objects from these experimental results. Therefore, we saw that it is necessary to statistically calculate the optimal parameter to increase the correct answer ratio.

3.2 Experiment of Robustness against All Difference of Visual Appearance

1) Experiment Overview: In this experiment, to show the robustness against seven properties mentioned above of the proposed method, we carried out the experiment while giving objects changes, and compared the correct answer ratio of the proposed method with the correct answer ratio of conventional methods. We used objects same as experiment of the number of division as the inspection object. In addition, we calculated the correct answer ratio by using equation (17). Here, we show setting of each method. In the proposed method, we defined the number of division as four pieces and σ of Gaussian filter as 1.0. In the Tanaka's method, we defined σ of Gaussian filter as 1.0. In SIFT, we defined the threshold of correspondence points as 70.0. In addition, we defined the object which has correspondence points more than ten points and most correspondence points as a detection result. In the Color Indexing, we defined 255 gradation which was divided into four as each axis of the histogram.

2) Experiment Results: In the experiment of scale change and rotation change, we only indicate the result of the proposed method without comparing the proposed method with the conventional methods, because both the proposed method and the conventional methods have robustness against the rotation change and the scale change.

a) The scale change: We carried out the experiment while increasing the scale level from 0.8 times to 1.2 times every 0.2. As a result of this experiment, the correct answer ratio was 100% in each scale level.

b) The rotation change: We carried out experiment while increasing the rotation degree from 0 degrees to 180 degrees every 90 degrees. As a result of this experiment, the correct answer ratio was 100% in each rotation degree.

We indicate the result of the experiment about robustness against the illumination change, the distortion by perspective projection and occlusion. In other expriments, we indicate the result of the proposed method and the conventional methods.

c) The illumination change: We carried out the

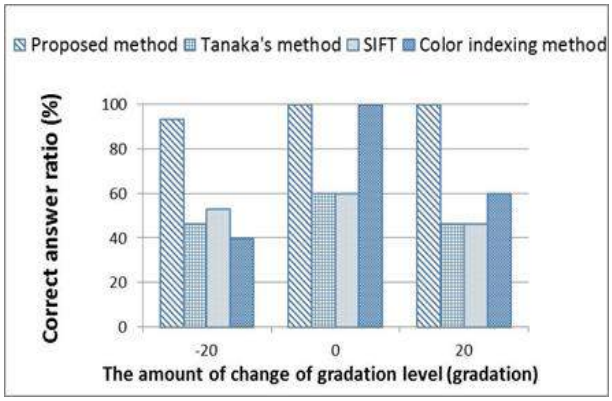


Figure. 19. The correct answer ratio of the experiment about the illumination change.

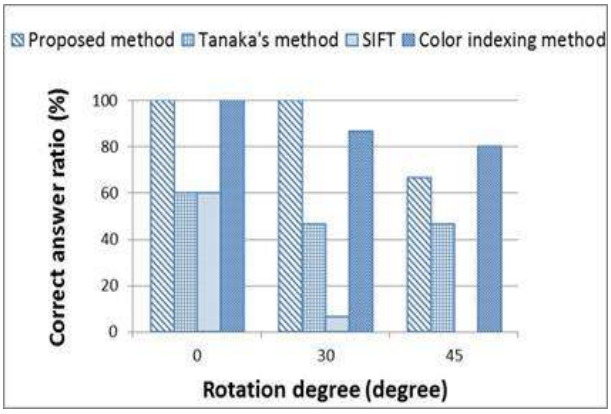
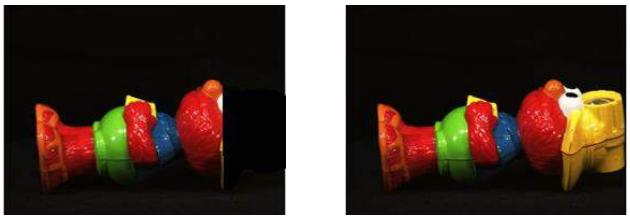


Figure. 20. The correct answer ratio of the experiment about the distortion by perspective projection.

experiment while increasing the gradation levels from -20 gradations to +20 gradations every 20 gradations. Fig. 19 shows the result of the experiment about the illumination change. As shown in Fig. 19, the correct answer ratio of the proposed method was the highest ratio, whereas the correct answer ratio of the Color Indexing was the lowest ratio as we expected.

d) The distortion by perspective projection: We carried out the experiment for the rotation in 30 degrees and 45 degrees. Fig. 20 shows the result of the experiment about the distortion by perspective projection. As shown in Fig. 20, the correct answer ratio of the proposed method was the highest ratio, whereas the correct answer ratio of the SIFT was the lowest ratio as we expected.

e) The occlusion: We carried out the experiment while increasing occlusion ratio from 10 percent to 40 percent every 10 percent. As an example, we show an occluded object in Fig. 21 (a). Fig. 22 shows the result of the experiment about occlusion. As shown in Fig. 22, the correct answer ratio of the proposed method was higher than the correct answer ratio of conventional methods as we



(a) Occluded object. (b) Original image of the occluded object.

Figure. 21. An example of the occluded object.

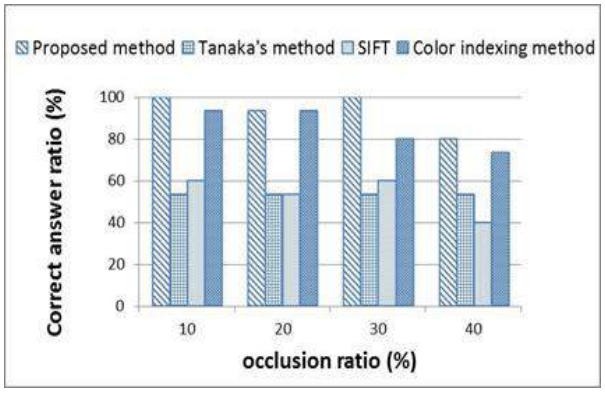


Figure. 22. The correct answer ratio of the experiment about occlusion.

expected.

In addition, we focus on the feature of the each object. Fig. 23 shows the correct answer ratio of the each object. As shown in Fig. 23, the proposed method and the Color Indexing obtained a high correct answer ratio in all features, whereas the SIFT obtained a low correct answer ratio in the object which has few texture. In addition, the Tanaka's method got a low correct answer ratio in the object having the same hue value and the normal object.

3) Discussions:

a) Proposed method: The correct answer ratio was higher or nearly equal than the conventional methods. However, the correct answer ratio decreased a little in case of 45 degrees of the distortion by perspective projection. The reason for this, since the local feature amount of the image was changed by perspective projection, the matching by the BRISK feature could not be performed well, and errors occurred on the posture estimation for the registered image and the input

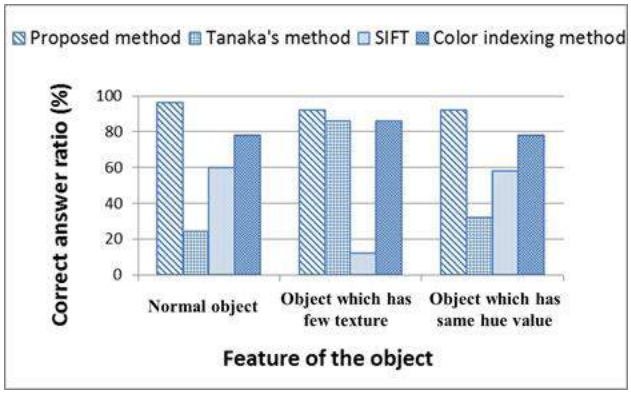


Figure. 23. The correct answer ratio for each feature of the object.

image. Thereby, it is thought that errors occurred on the position of the unevenness of the hue histogram within the divided areas, and the recognition ratio decreased.The correct answer ratio was higher or nearly equal than the conventional methods. However, the correct answer ratio decreased a little in case of 45 degrees of the distortion by perspective projection. The reason for this, since the local feature amount of the image was changed by perspective projection, the matching by the BRISK feature could not be performed well, and errors occurred on the posture estimation for the registered image and the input image. Thereby, it is thought that errors occurred on the position of the unevenness of the hue histogram within the divided areas, and the recognition ratio decreased.

b) Tanaka's method: The correct answer ratio was less than 60% in all changes. However, we see that there are few differences by comparing the correct answer ratio in the object which a change is given and the correct answer ratio in the object which a change is not given. Therefore, there seems to be other reasons why the correct answer ratio of Tanaka's method decreased. So, we focus on the feature of the each object. As shown in Fig. 23, the correct answer ratio was low in the object having the same hue value and the normal object. The reason for this, since Tanaka's method uses the position of the unevenness of the hue histogram in whole object area as feature descriptor, the Tanaka's method can not distinguish different objects having the same hue value. Furthermore, when objects have plural pieces of color information, they have the same hue value with high probability, therefore it is thought that erroneous recognition occurred in a normal object as shown in Fig. 16 (a) and the correct answer ratio decreased.

c) SIFT: The correct answer ratio was less than 60% in all changes. Especially, the correct answer ratio decreased on the distortion by perspective projection. The reason for this, the local feature amount changes by the distortion by perspective projection, therefore it is thought that the SIFT descriptor changes and the correct answer ratio decreased. In addition, we focus on the feature of the each object. As shown in Fig. 23, the correct answer ratio was low in the object which has few textures. The reason for this, the SIFT descriptor uses the gradient information of the object, therefore it is thought that the SIFT could not detect the feature amount on the object which has few edges such as the object which has few textures, and the correct answer ratio decreased.

d) Color Indexing: The correct answer ratio decreased on the illumination change. The reason for this, the RGB color system which is used for the Color Indexing is easy to be affected by the illumination change, therefore it is thought that the value of the three-dimensional color histogram changed and the correct answer ratio decreased.

4 CONCLUSION

In this study, we proposed the object detection method using invariant feature based on the local hue histogram in divided areas of an object for the human support robot. To show that the proposed method satisfies all seven properties as follows,

1. Robustness against the rotation change
2. Robustness against the scale change
3. Robustness against the illumination change
4. Robustness against the distortion by perspective projection
5. Robustness against the occlusion
6. Detecting an object which has few textures
7. Detecting different objects which have the same features of the hue histogram

We carried out experiments. As a result, we could show that the proposed method satisfies all seven properties. However, the detection accuracy is limited, because the proposed method uses only two-dimensional information. Therefore, in the future, we aim to improve the ability for detection by using three-dimensional information such as the shape information.

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Epidemiological Simulation Of A Nonlinear Computer Network Laboratories Using Kermack-Mckendrick Model

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ABSTRACT

Computer viruses, malware, worms, spyware, and the like have shown a significant impact in the digital world today. It has shown its power to destroy computer systems and hardware and most of the time used for hacking, spying, and other cyber crimes. With this scenarios, it empirical to unravel the story behind computer network laboratories using Kermack-McKendrick model through simulation of a nonlinear network using NetLogo v.6.0 in an actual setting happened in a Philippine teacher education institution. Results revealed the impact of the computer viruses and the difference between a free antivirus and a licensed software antivirus in the computer network laboratories. Finally, with this initiatives, the university decided to purchase a licensed software antivirus as it is deemed necessary to protect the end-user from the computer viruses and the equipment itself for long term use, savings, and helping the environment as a whole.

Keywords: simulations and modeling; computer viruses; Kermack-McKendrick Model; nonlinear network; computer security; quantitative; Philippines.

1. INTRODUCTION

Over the last few years, publications appeared on the subject of computer viruses and malware were very few. Works such as technical details that were necessary to understand and effectively defend against computer viruses [1] were some of those. The attacks caused by viruses and malware mostly came from the internet [2][3]. Moreover, these computer viruses and malware nowadays were being used in cyber crimes like hacking using the internet as a deployment tool considering that millions of internet users are online every day. Based on history, computer viruses arose in the 80's [4] and had made a significant impact on the computer network and the internet. Among those was the infamous *iloveyou virus* that causes billions of dollars in loss and damages [5]. In the current years, the rapid development and utilization of hardware and software technologies and the popularity of computer network and the internet (e.i. Social media) had made a significant threat and getting more severe [4] in terms of predicted results when these viruses and malware attacks and activated in the computer systems. Only recently, however, researchers began to study the patterns of connectivity and the activities made by these viruses and malware, the ability to handle perturbation or attack, and the ability of the ecosystem to handle disturbances [6].

2. MODEL

SIR Model

A SIR model is an epidemiological model that calculates the hypothetical number of people infected with a contagious illness in a closed population

over time. The name of this class of models derives from the fact that they involve coupled equations relating the number of susceptible people ***S(t)***, the number of individuals infected ***I(t)***, and some individuals who have recovered ***R(t)***. One of the simplest SIR models is the Kermack-McKendrick model [7].

Kermack-McKendrick Model

The Kermack-McKendrick model [8] is a SIR model (S-Susceptible, I-Infected, R-Resistance) for the number of people infected with a spreadable illness in a closed population over time. It was predicted to elucidate the fast rise and fall in the number of infected patients observed in epidemics such as the plague (London 1665-1666, Bombay 1906) and cholera (London 1865) [9]. The fixed population size was adopted (i.e., no births, deaths due to disease, or deaths by natural causes), the incubation period of the infectious agent is instantaneous, and the duration of infectivity is same as the length of the disease. It also assumes an entirely homogeneous population with no age, spatial, or social structure.

3. METHODOLOGY

The experimental and descriptive design was utilized in this research to test the variability of a computer virus infect other computers in a nonlinear computer network established in a university computer laboratory. First, this research conducted an investigative approach to observing, analyzing, and understanding the infrastructure of the network topology design implemented in the five (5) computer laboratories in the university. Students were using these computer laboratories across disciplines in the university. Second, the gathered information was used as a basis for SIR simulation in a nonlinear computer network prior, during and after the virus and malware attack. NetLogo 5.2.1 version [10] was utilized using the existing model on the *SIR Model for Computer Viruses and Malware* in the experiment. This model demonstrates the spread of a virus through a network. Although the model is somewhat abstract, one interpretation is that each node represents a computer, and we are modeling the progress of a computer virus (or worm) through this network. Each node may be in one of three states: *susceptible*, *infected*, or *resistant*. In the academic literature, such a model sometimes referred to as a SIR model for epidemics [11]. In continuation, the *Number of Nodes* represents the total number of computers in the laboratories; *Average Nodes Degree* represents the number of computers that are connected or has the network permissions; *Initial Outbreak Size* is an estimated number of computers that are computer virus infected. While the *Virus Spread Chance* set at 2.5% is a percentage probability of a computer to be infected, by default as suggested by Stonedahl and Wilensky. Furthermore, *Virus Check Frequency* represents the time step increment (tick), this is used to do nodes check whether they were infected. While *Recovery Chance* was used identifying when the virus has been detected and has the probability to be removed, then the *Gain Resistance Chance* is a node recover, from the virus, then there is a probability that the node will become resistant to this virus in the future.

This research employed the SIR Model using the Kermack-McKendrick Model. The model consists of a system of

three coupled nonlinear ordinary differential equations,

(1) dS/dt **(2)** dI/dt **(3)** dR/dt

Where ***t*** is time, ***S(t)*** is the number of susceptible nodes, ***I(t)*** is the number of nodes infected, ***R(t)*** is the number of nodes which have recovered/resistant and developed immunity to the infection, β is the infection rate, and γ is the recovery rate.

The key value governing the time evolution of these equations is the so-called epidemiological threshold,

(4) $R_0 = \frac{\beta S}{\gamma}$

Note that the choice of the notation R_0 is a bit unfortunate. Since it has nothing to do with ***R***. R_0 is defined as the number of secondary infections caused by a single primary infection; in other words, it determines the number of nodes infected by contact with a single infected node before its death or recovery.

When $R_0<1$, each node who contracts the disease will infect fewer than one node before dying or recovering, so the outbreak will peter out $(dI|dt < 0)$. When $R_0<1$, each node which gets the virus will infect more than one node so that the epidemic will spread $(dI \mid dt < 0)$. R_0 is probably the single most significant quantity in epidemiology. Note that the result $R_0 = \beta S/\gamma$ derived above, applies only to the basic Kermack-McKendrick model, with alternative SIR models having different formulas for $dI \mid dt$ and hence for R_0.

NetLogo Design and Set-up(see figure 1 and 2)

Input Variables and description:

Number-Of-Nodes = is the total number of computers in a network. In this case, there are 185 computers (nodes) in the computer laboratories.

Average-Node-Degree = is the number of servers in the computer laboratories. The use of these servers is for file sharing purposes only.

Initial-Outbreak-Size = is the number of computers assumed infected by viruses and or malware through either connecting the internet using emails, downloading, using social networking sites, and using secondary devices like flash drive, CDs, and others.

Virus-Spread-Chance = is the probability of infecting susceptible computers and neighbors (nodes). Virus-Spread-Chance is an assumed value in percentage.

Virus-Check-Frequency = the frequency of the computers checked whether a virus infects them.

Tick = is the time step each infected node attempts to infect all of its neighbors. One (1) tick is equivalent to 1 milliseconds. Tick1 is the time step of Free Antivirus Software while Tick2 is the time step for Licensed Antivirus Software.

Recovery-Chance = is the number of times the user conduct virus scanning and applying quarantine and deleting the viruses and or malware. Recovery-Chance is an assumed value in some scanning, quarantine, and deleting viruses and malware.

Gain-Resistance-Chance = is an assumed value in percentage if a

node does recover, there is some probability that it will become resistant to this virus in the future.

Output Variables and Descriptions

Susceptible = these are nodes (computers) that are likely to be influenced or infected by a virus. Susceptible_1 were the values incurred based on the parameters defined for a Free Antivirus Software (FAS), while Susceptible_2 were the values incurred based on the parameters defined for a Licensed Antivirus Software (LAS).

Infected = these are nodes (computers) that were infected by a computer virus.

Resistant = these are nodes (computers that were infected and were able to resist from a computer virus. Resistant_1 were the values incurred in the given parameters defined for FAS, while Resistant_2 were the values incurred based on the parameters defined for LAS.

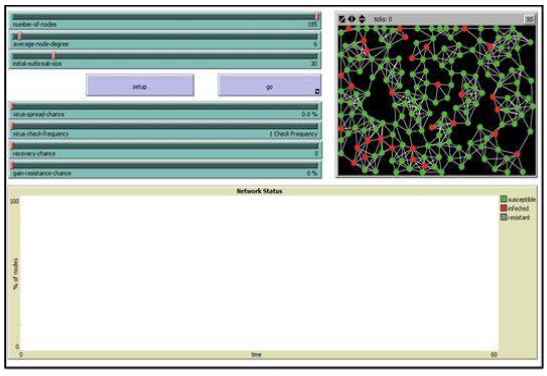

Figure 1: NetLogo 3D Real World Representation of Nonlinear Computer Network

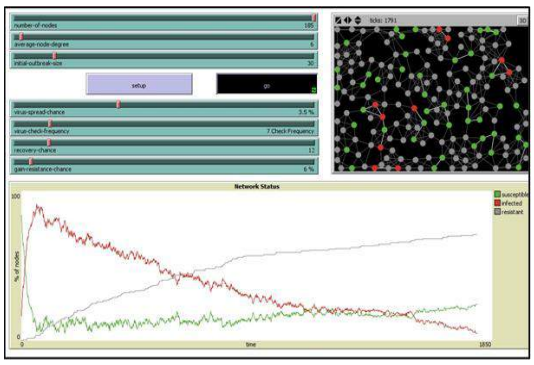

Figure 2: Sample Simulation Output of Real World Nonlinear Computer Network

4. RESULTS AND DISCUSSIONS

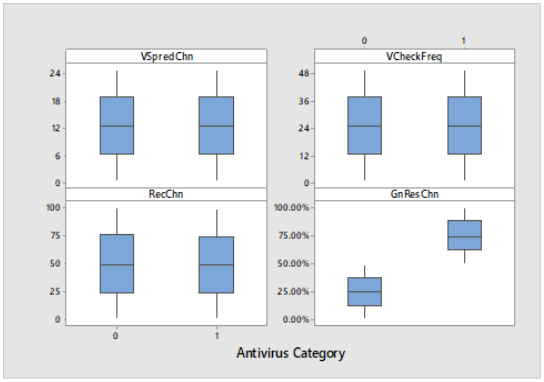

Figure 3: Boxplots of Input Variables

Figure 3 illustrates the difference between a FAS and LAS based on the virus spread chance, virus check frequency, resistance chance, and gain resistance chance. As observed, the gain resistance chance of a LAS has higher Gain Resistance Chance than FAS.

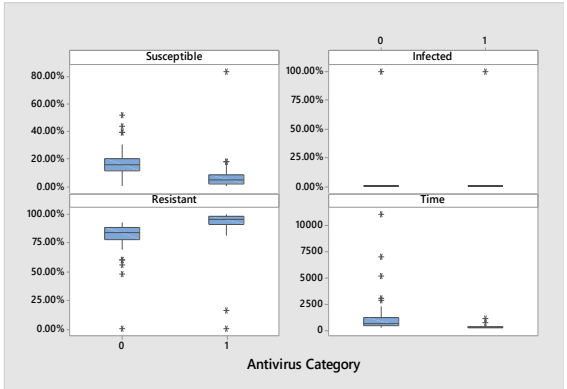

Figure 4: Boxplots of Output Variables

Based on the results from the simulation, Figure 4 shows the difference between FAS and LAS based on *Susceptibility, Infected,* and *Resistant (SIR)*. Regarding Susceptibility, FAS is more susceptible than LAS after the simulation while, regarding Infected Nodes, both at one time, in the beginning, were infected. Moreover, LAS group is more resistant to computer viruses than the FAS group. Finally, LAS group processes faster than the FAS group regarding performance time evaluation.

Table 1. Paired Samples Statistics – Time Spent in Processing

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Tick1	1230.2000	50	1883.51654	266.36946
	Tick2	283.0600	50	161.29848	22.81105

Table 1 shows the Paired Samples Statistics Mean on Time Spent in Processing (Tick) with 1230.2 for Tick1 and 283.06 for Tick2 from 50 samples. The result implies that *Tick1* spent much time in the simulation than *Tick2*.

Table 2. Paired Samples Correlations – Time Spent in Processing

		N	Correlation	Sig.
Pair 1	Tick1 & Tick2	50	.814	.000

As shown in Table 2, the paired sample correlations on time spent in processing indicate that *Tick1* and *Tick2* scores are significantly positively correlated (*r=0.814*). As a result, a strong association was established between the two variables.

Based on Table 3, the average difference between the *Tick1* and *Tick2* is 947.14 with Std. Dev. of 1754.76 and Std. Error Mean of 248.16. On the other hand, *Tick1* and *Tick2* scores were vigorously and positively correlated (*r=0.814, p<0.000*) and there was a very highly significant average difference between *Tick1* and *Tick2* scores (t_{49} = *3.817, p<0.000*). On average, *Tick1* scores were 947.14 milliseconds higher than *Tick2* Scores (95% CI [448.44, 1445.83]).

Table 4. Paired Samples Statistics - SIR

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Susceptible_1	.1784	50	.09982	.01412
	Susceptible_2	.0698	50	.12144	.01717
Pair 2	Infected_1	.0200[a]	50	.14142	.02000
	Infected_2	.0200[a]	50	.14142	.02000
Pair 3	Resistant_1	.8018	50	.15101	.02136
	Resistant_2	.9106	50	.17857	.02525

a. The correlation and *t* cannot be computed because the standard error of the difference is 0.

Table 4 shows the paired sample statistics of the SIR results that the correlation and the *t* value cannot be computed of the *Infected_1* and *Infected_2* because the standard error of the difference is 0. Looking into the simulation results, it shows that at the start of the simulation of both groups; the Virus Spread Chance is at 0.50, Virus Check Frequency is at 1, Recovery Chance is at 0, and the Gain Resistance Chance is at 0 % (for free antivirus) and 50 % (for a fee antivirus) resulting to 100% Infection to all nodes (computers). Moreover, the rest of the values after the first simulation showed 0% Infections.

Table 3. Paired Samples Test – Time Spent in Processing

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1 Tick1 – Tick2	947.14000	1754.76798	248.16167	448.44046	1445.83954	3.817	49	.000

Table 5. Paired Samples Correlations - SIR

		N	Correlation	Sig.
Pair 1	Susceptible_1 & Susceptible_2	50	.438	.001
Pair 3	Resistant_1 & Resistant_2	50	.751	.000

The paired sample correlations in SIR results as shown in Table 5 revealed that *Susceptible_1* and *Susceptible_2* (*r= 0.438*) and *Resistant_1* and *Resistant_2* (*r=0.751*) were significantly positively correlated.

5. CONCLUSION

Free Antivirus Software processing time is slower in determining SIR than Licensed Antivirus Software. While regarding SIR, the Free Antivirus Software has higher *Susceptibility* to computer viruses than Licensed Antivirus Software. Moreover, both groups were infected with computer viruses at one time at the beginning of the simulation revealed.

Table 6. Paired Samples Test - SIR

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Susceptible_1 - Susceptible_2	.10880	.11871	.01679	.07506	.14254	6.481	49	.000
Pair 3	Resistant_1 - Resistant_2	-.10880	.11905	.01684	-.14263	-.07497	-6.462	49	.000

The paired sample test in SIR shown in Table 6 shows that *Susceptible_1* and *Susceptible_2* scores were average and positively correlated (*r=0.438, p<0.001*). Moreover, there was a significant average difference between *Susceptible_1* and *Susceptible_2* scores (t_{49}*=6.48, p<0.000*). Meanwhile, *Susceptible_1* scores were 0.10880 points higher that *Susceptible_2* scores (95% CI [0.075, 0.142]). *Resistant_1* and *Resistant_2* scores were strongly and positively correlated (*r=0.751, p<0.000*). While there was a negative significant average difference between *Resistant_1* and *Resistant_2* scores (t_{49}*=-6.46, p<0.000*). Finally, *Resistant_1* scores were -0.10880 points lower that *Resistant_2* score (95% CI [-0.142, -0.074]).

Finally, it revealed in the groups (FAS & LAS) that both were able to resist from computer viruses, but Licensed Antivirus Software has a higher value in resisting computer viruses. Moreover, the use of simulation and modeling software helps further understand the capabilities of different software like computer antivirus and the like to give decision support to administrators in real life situation. Finally, the researchers were able to enlighten the possible research area in simulations and modeling in an actual situation by looking into in-depth computer security simulation of the same area.

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Temperature and Humidity Management of the Storage Houses of Food Using Data Logger

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ABSTRACT

Because of commercial fraud, and high and low temperature and humidity in the environment that lead to food spoilage and this may affect the health of the consumer. People need an efficient way to maintain the safety of food products and consumer health. To control this problem, this paper proposed a solution using the data logger by connecting it to a computer. The data logger is a device that records the temperature and humidity of food products at regular times (depending on the minutes, hours, date), it displays them as fees graphic schemes. Therefore, it becomes easy to read.
The results of these papers showed that for each environment different temperature and humidity. The data logger has proved its effectiveness in accurately recording the readings to prove the safety of the product by taking readings regularly, and this helps in controlling the problem of damage to products.

KEYWORDS

Data logger, Mobile Application, OSX, Use Case Diagram.

1 INTRODUCTION

Lord Kelvin says, " When you can measure what you are speaking about, and express it in numbers, you know something about it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely, in your thoughts advanced to the stage of science."[1]. It is known that the capacity of the human self- limited. However, increasing human capabilities led to invent a lot of scientific instruments that help to understand and examine objects and phenomena surrounding, that is the most important devices that helped the man to come to the realities of things are gauges that evolved dramatically in the context of the massive industrial development that followed the Second World War.

As we cannot separate between scientific advances and industrial progress and that because any scientific discovery followed by discoveries in the field of industry, technology and the attendant development of new ways and means to carry out the measurement or observation or recording. Thus, increased the variables that need to be a precise measurement, and increased attention to improving methods of measurement and development Instrumentation and even in the lives of their human interest shifted to the attention of the kind of type and quantity together. The meaning of quantum measurement and measurement requires the use of the device, and use knowledge to use right what is the measurement. It is finding the amount of physical or variable physicist or estimate the case using a suitable or appropriate tool. Moreover, if the user device standard universally agreed considered the measurement calibration process, the quantity will be measured by the standard amount. However, if the device is not a standard, it must compare the measurement process with the standard amount used in this device, which is calibrated before. Moreover, calibration devices used to compare with normative universally agreed-upon terms of accuracy and reserved under specific environmental conditions. There is universal agreement on the measurement titer and the units of measurement Fahrenheit and Celsius or humidity. Any measurement process requires the use of a measure and despite the fact that there are a large number of devices, which are not electric [2]. However, the general trend in the industry and research laboratories has become an

attempt to use electrical appliances. Also, it called electronic devices and caused this trend is the ease of use of electrical devices and convert them to digital devices and easily connect to other devices help to record the readings or saved in computer peripherals, making it easier and statistical calculations.

2 THE HISTORY OF COOLING SYSTEMS

The ancient Egyptians are the first in the world in discovering the cooling. In the Upper Egyptian town, people used the clay pottery and salt with water and milk, and left on the banks of the Nile under the willow trees and found that the water is cold, and they start to drink the cold water.

Then followed by a state of ancient China in 3000 BC, Macedonians (the era of Alexander the Great) in Greece and the Romans. In Mediterranean countries, the other in the eighth and ninth bought Khalifa Baghdad sundae called Sorbets from Spain during the Islamic conquest, the Sultan of Egypt, bought ice from Lebanon, and used it in the palace kitchens in the eleventh century. The first mechanical refrigeration units were operated in the United States in 1881 in Boston. Before that, they were using natural ice-cooling tubes containing calcium chloride and riding behind pipe fan to push air passes air through the pipes to cool down and then cooled storage rooms. The first attempt to build a Storage business in America was in 1898 where he set up Storage to save the Dairy cooled with ice natural. In 1908 became the strings of such stores 180 000 cubic meters owned by 23 properties (17 facilities using mechanical refrigeration and 6 of them are using natural snow and salt, calcium chloride) [8].

3 PROBLEM DISCRETION

Each adoption of maintaining good food to see the proper storage of each type of food to protect it from pollution due to high humidity and temperature are favorable for growth and reproduction of microbes and viruses, especially if the storage process is terrible. Control the storage environment regarding temperature is considered a most common way effective to reduce the number of microbes, prevent their spread and ruin food or medical during storage. Therefore, it must provide all the nutrients at the proper temperatures, either refrigerated or frozen, and its importance to human health must be preserved and taken care of.

These are some of the problems, which are harmful to human health:

- Spoiled foods (such as meat).
- Moving from one state to another by trucks.
- Spoiled foods in supermarkets.
- Bad blood in the blood bank refrigerators (blood bags).

These problems do not occur all intentionally but may have found a technical malfunction or electric in refrigerators.

This paper presents an idea of a device measured the temperature, to help organizations and others that need to take caution and precaution to maintain human health.

Therefore, to solve those problems and to maintain the health of these human damages, (USB Temperatures and humidity sensor or Data Logger) device has been chosen. In addition, to ensure the quality of foods as they move between states, also to achieve transparency and to ensure consumer confidence.

4 RESEARCH IMPORTANCE AND OBJECTIVES

- Choosing the appropriate temperature grades for each class food or medicine.
- Posted the appropriate knowledge and special storage refrigerators.
- Facilitate the process of knowing the temperature and humidity suitable for storage.
- Reduce the cost of storage.
- Achieve profits and returns on institutions.
- Depression and reduce the amount of damage to the food stored.
- Limiting the spread of bacteria that live in the high temperatures.
- Working knowledge of the basics that are adapted to store meats and seafood, vegetables and fruits.
- Show temperatures in the form of data that can be controlled and knowledge and take advantage of them.

- Using the technology to determine the temperature and humidity appropriate for most vital Products.

5 SYSTEM AND RESEARCH CONSTRAINTS

5.1 System Constraints:

- Lack of understanding of the old system clearly.
- Scarcity of resources and take the information from the system.
- Difference and the gap between the current system and the new project.
- Lack of information for workers to use the Internet.
- The urgent need to train staff to use the new system.
- Lack of modern equipment and servers bear the huge number of visitors and the data.

5.2 Research Constraints:

- The lack of a previous regime to understand the idea of the project.
- Some libraries refuse to give information on their systems for fear of theft and loss of information.
- High material cost of the research.
- Limited time for research.
- Some things in the project require deep study of their work.
- Some things within the project require high effort to hold them.
- Some things within the project requirements cannot be implemented and will be transferred to future work.

6 VI. RELATED WORKS

There are many applications and research regarding the measurement of temperature Measurements of skin temperatures.

Norman, R., J. Henfling, and D. Blackwell, in 1996, presented the most important study made for the use of Data Loggers sensor in measuring the temperature of the human body skin. There are two ways of the wired sensor. There are many studies in this regard. This study aims mainly at describing how I-Button is used in the shape of wireless for measuring the temperature of human skin. This article describes a wireless temperature system for human skin this study deals with proof of the Data Logger and its application to the human skin temperature [4].

In 2006, van Marken Lichtenbelt, Wouter D., et al. presented a study which has been validated by the accuracy of the Datalogger sensor which can reach the amount of 0.09 °C (− 0.4 °C at most). Such use of the Data Logger these properties can be developed for more and better result by calibration [5].

According to the Kit L. Yam study (October 2009), the use of Data Loggers can include many complementary technology applications such as approximately. In addition, smart cards, which differ from other temperature sensors, the Data Logger, exceeded the limitation of the digital memory [6].

Also, it showed via experiments, the accuracy of using I buttons in measuring temperature via using more nearly 30 Data Loggers sensors, they were all put in the water bath, coated in a net and mesh the same was done with a calibrated thermostat. The water bath is to be contained at a constant heat level for 15 minutes.

The Data Logger proved their own ability to measure temperature more than the usual thermostat.

Another experiment is showing the validity of the Data Logger via having two vessels of water with foam polystyrene filled all with different temperature water. The number of 8 Data Logger sensors with a calibrated thermometer which is to be put loosely in a tube holder. There was enough room and space among the Data Logger to be surrounded with water The Data Loggers are submerged into the water = 8.7 °C and next, immediately after the prompt measurement, put in another water vessel with water = 41.3 °C. The example rate was set to one taster per minute [6].

In 2005, JOHN PORTER, PETER ARZBERGER and others in their paper described the Data Logger sensor as one of the

developed sensors, which is used automatically, and according to the net with wireless for different uses even in the temperature control. For the study, a sensor of Data Logger type can be used for measuring physical aspects including temperature and other biological functions via converting the signal it traced and detected to be in the shape of information or data. Data Logger can be seen as a bridge between the physical world in the electrical and electronic world for measuring and monitoring experience [7].

7 DATA LOGGER

A data logger is a device with processor-controlling storage memory unit, which receives and collect the data in a specific Sensor temperature, and humidity and stores it on a storage medium memory. This can be done by software if the present data to be logged. For example, information within a computer already in digital form and only need to be treated. If the information is only in the non-electrical form available, the data logger from a special combined with hardware sensors can be made to capture the physical measurement data over a specified period of time, such as temperatures, voltages, and accelerations. Some data recorders can be reached with a personal computer to capitalize on and activate the software, the device could be with (keyboard, display), and the user can use it as a standalone device as shown in Figure (1), which is shows the Data Logger system.

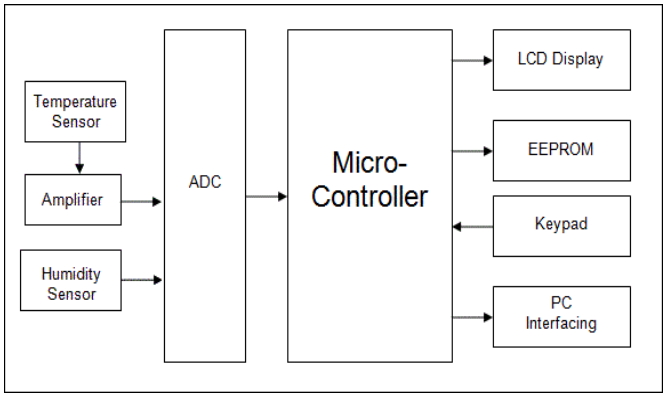

Figure 1. Data Logger System

There are many data recorders, which requires the development of an application on your computer so that data is processed, and these records are characterized as the high-resolution, but have no attribution error is limited and can use the application comes with the device it where it is to identify the data and applied using a computer program. There are some data recorders, which contain information, analysis alone without resorting to the computer and in the Fig (2) its show the device that we use in our project.

Figure 2. Data Logger Device

One of the main benefits of the use of data recorders is the ability to collect data on the basis of 24 hours automatically. When activated, the deployment and are usually put data recorders and left without processing to measure and record information for the duration of the monitoring period. This allows for comprehensive and accurate pictures of the environmental conditions being monitored, such as air temperature and relative humidity.

Depending on the use, governed by a quality management system sometimes need to calibrate compared to global standards and protocols official commitment to verification and validation can be based Options temperature data recorders on many factors, such as:

- Cost.
- Reuse.
- Battery Life.
- Ease of use; construction, ease of reading, downloads, and analyzes data, etc.
- Temperature range.
- Efficiency and accuracy - the extent of the consent degree registered with the actual temperature.

- Response time - the time required for approval of the temperature recorded with real Resistance to shock and vibration.
- Water resistant - humidity, condensation, etc.
- Size, weight, and composition.
- Certification, calibration, etc.
- Software

8 USES OF THE DATA LOGGER

8.1 Environmental Monitoring

Can be taken as data recorders, independent sites varied that cannot be easily supported with temperature monitoring fixed. Applications, data, logger temperature model include the mountains and deserts, forests, mines, and flows of ice, etc. Using data recorders also portable in the industrial laboratories and unwanted conditions for registration in the independent [9].

8.2 Using temperature data logger in factories Monitoring and recording of temperature

It is vital in many manufacturing processes. In the food industry often uses temperature data logger to ensure that is stored unprocessed foods at the right temperature in cold stores. It is also used in furnaces and production lines to ensure that the food has been heated to the correct temperature the length of time required [9].

8.3 Monitor shipments Temperature

There are many products in food, and medicine that needs to keep it safe during the process of shipping. Because of the poor storage process can happen some disrepair and ruin, or a change in the chemical structure where it should be on companies specialized freight operations to make sure to adjust the temperature and humidity of the shipping carriers. As high temperatures or moisture may cause the destruction of products is compelling put control devices and sensors to record data to ensure quality safety product upon arrival. There are studies in different indicate that the walls of the tankers non-isolated well may be affected by the rapid factors change the atmosphere and temperatures to affect negatively on the products contained inside therefore be put your data logger to monitor changes in temperature and humidity in the tanker [9].

9 THE POTENTIAL TANGIBLE AND INTANGIBLE BENEFITS OF THE APPLICATION

9.1 Tangible Benefits

- Increased share.
- Cross-selling/ selling up.
- Revenues from advertisers.
- Move business into more profitable areas.
- Improved margin on direct business with students.
- Reduced stock lead times.
- Improved stock control.
- Improved speed of processing.
- Improved accuracy of processing.
- Improved efficiency and productivity of staff [2].

9.2 Intangible Benefits

- Improved student service.
- Improved information and feedback from Companies.
- Improved sales forecasting.
- Better materials requirements planning.
- Improved purchasing information.
- Improved production scheduling.

10 FUNCTIONAL REQUIREMENTS

- Data logger unit.
- USB cable.
- CD ROM.
- 3 Volt, lithium battery CR2032.
- Windows XP, Vista, 7, 8.1.
- Microsoft Excel 2010.

11 NON-FUNCTIONAL REQUIREMENTS

- Program design attractive and stylish.
- Clarity and ease of use.
- Ease of handling.
- Compatible with most operating systems.
- Colors suitable for use faced.
- All information found on one page, making it easy for the user to reach him.
- The small size of the program, which means it does not need a long time to download and installed.

- Easy to install the software on a computer.
- Access to all the data to several forms [10].

12 HOW THE PROGRAM WORKS

In this section, images from the system will be displayed with a simplified explanation of each image.

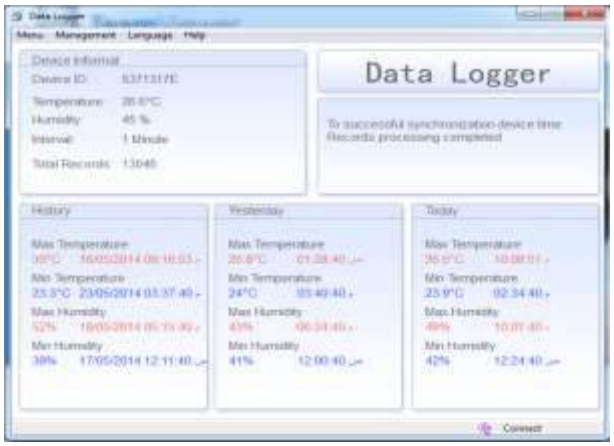

Figure 3. Main intro page

Figure (3) shows the Main page for the program, which it displays a summary of the data that recorded within the device. It contains the device information such as device ID, current temperature, humidity and the rate of change in minutes. In addition to the number of data, that recorded in the memory of the device. It also shows the last summary data such as high temperature and humidity were recorded in addition to the date on which it was recorded, as well as lower temperature and humidity.

The second section of the Main page displayed the previous day and the current day. The user can recognize that the program has been successfully linked with the device through the emergence of a communication signal in a corner Program. This page also contains a taskbar to move around between pages programs.

Figure 4. Setup program and device

Figure 5. Setup program and device

Figure 6. Setup program and device

Figure (4), (5) and (6) show the setup page, which is viewed by pressing the Menu button and then press Setup. The user can control the temperature Unit, Date display system, in addition to the coefficient of interval time in the minutes.

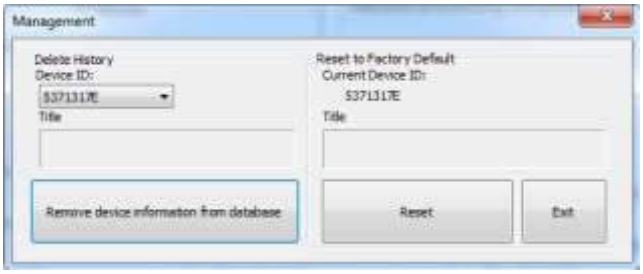

Figure 7. Management of the device

Figure (7) shows the Management page. The user can view this page by clicking on the Management button located at the top of the taskbar of the main page of the program. This page provides the user to erase existing data that is stored in the memory the device reader. It stores the data of temperature and humidity with the device ID. The user can erase the records by clicking the left button appears on the screen "delete the device information from the database." In addition, it provides the user to restore the factory settings or the default settings of the program and the device.

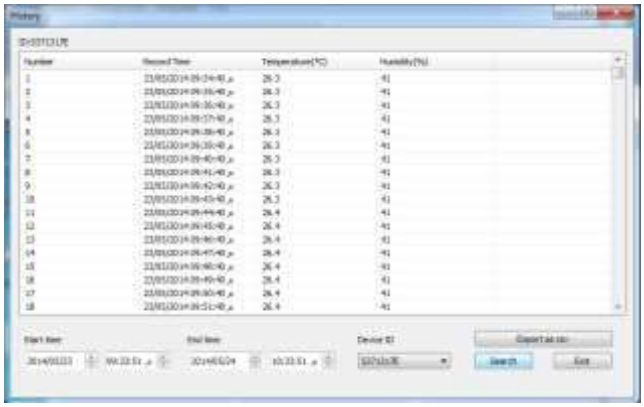

Figure 8. Data History

To view this screen (Figure 8), the user should press the setup button and then history. This page shows a review of the data that is stored in the device memory, and selecting the start date and time, end date and time, then click on the Search button. In case of date selection far can program takes the time to show results, all results that show us on the screen can be exported as an Excel file format.

Figure 9. Graph of the data

In Figure (9) can be shown by pressing the Setup button and then Graph. This page subjected the recorded data in the device memory in the form of drawing Graph by selecting the start date and time and end date and time, and then select the graphic Is it the temperature or the amount of moisture. Then click on the search button. Results can be exported in an image form.

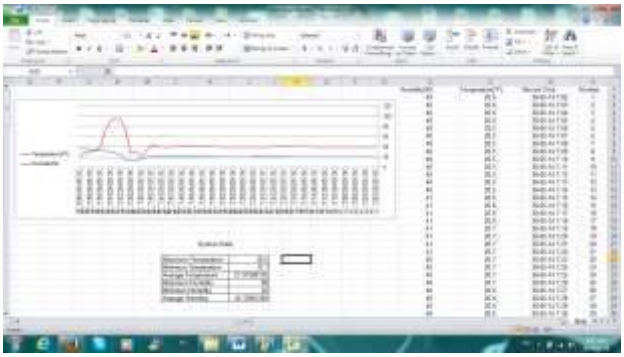

Figure 10. Excel File

In this section's data is displayed in an Excel file form in order to facilitate the presentation of data and modify them, and it displays some parts of the calculations as shown in Figure (10).

13 IMPLEMENTATION

While using the data logger device, it must set a date and time to be reading accurately, and that may require sometimes plugging the device into the computer using the USB port.
After making sure, that the device is working properly and is now equipped with senses that the temperature begins to take data.

Senses temperature and moisture on an ongoing basis and because space high data memory where the intervention of this process infinitely, continuous and it is through the device calculating the amount of time that has passed for another read operation.

As shown in Figure (11), it is re-reading every minute where the search continues in a minute if exceeded minute it records the data, and then goes back to search again. Then it stores the data in memory if the memory is full, the device is unable to re-reading, so it separated from the sensor reading in and out of his throat continuous reading. Alternatively, it stopped in the event of an interrupt in the sequence of event data flow of the device through some roads. Such as the memory is full or the end of the

battery or detach the device, which is based on the region where the reading.

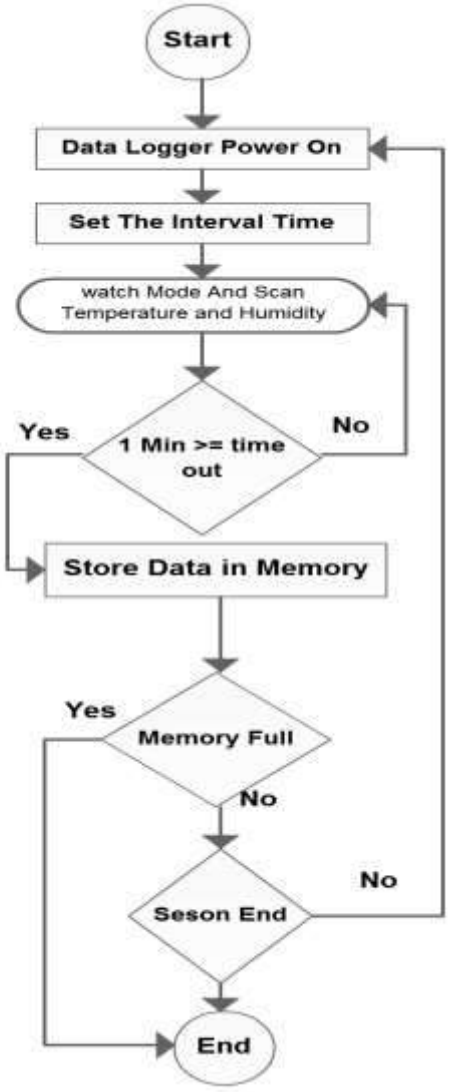

Figure 11. Flow Chart of Data Logger Working

14 RESULTS

In the measurement process, the program compares the accurate information from the device to know the amount or a variable amount or determine the status in any standard process. Figure (12) shows the temperature and humidity results.

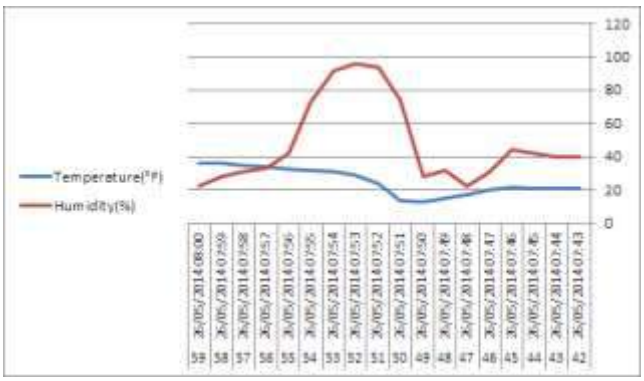

Figure 12. temperature and humidity results

The change in temperature and humidity can be seen clearly in the experience, and that leading up to know the amount of change in temperature and humidity, as shown in Figure 12, which shows the chart for temperature and humidity result, where X-Axis represents the time and the average change of time in minutes. Moreover, Y-Axis represents temperature and humidity with some Lama.

Converting the energy to run the machine is not usually done without affecting the state of the thing. It cannot measure the degree of room temperature without putting the data recorder. Any process of measuring energy has been converted from one form to another may affect device on the quantity measured thus; the measurement must be pursuant careful, precise aims to get information about something without affecting it.

The numbers alone do not have a mean only if we have identified the units expressed. It is not enough to say that the temperature of the meat truck five, but we must say five degrees Celsius. Thus, we must mention the numbers and units of global or global derivatives units. The best temperatures for each food is shown in the following table (Table 1):

Table 1. Best Temperatures for keeping Food table

Foodstuffs chilled	Temperatures
Fresh sea products, especially fish, crustaceans	+2 °C
Meat and meat chopped	+3 °C
massacre in unit sale to the consumer	+3 °C
	+3 °C
Pre-cooked meals	
Cold meals prepared on the same day, sandwiches and gravy	+3 °C
	+3 °C
Summary	+4 °C
Modern –made	+4 °C
Refreshments, generous	+6 °C
Refreshments and fresh pastries	+6 °C
	+6 °C
Poultry, rabbits, meat hunting	+10 °C to +15 °C
Products containing eggs	
Eggs chilled	+7 °C
Raw milk, pasteurized	+8 °C
Products of fresh milk are pasteurized fermented milk and cream, sweetener	+10 °C
	+15 °C
	+15 °C
Butter	
Fresh cream, fresh cheese	
Cheese with a soft dough, cheese, dough is blended with parsley	
Other cheese	
Meat with bone and machining	
Milk -oriented industry	

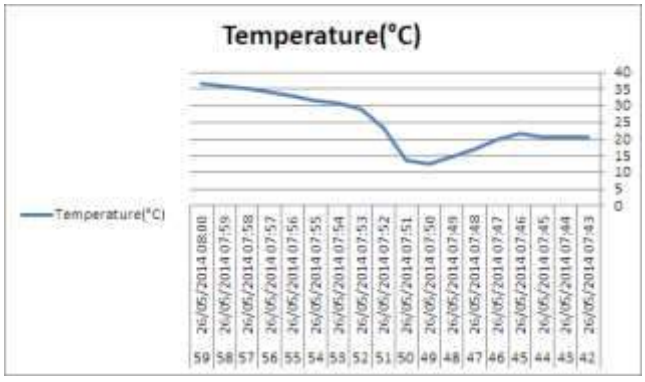

Figure 13. temperature results

Figure (13) clarified only the change of temperatures in order to understand the information and data correctly, where X-Axis represents the time and the average change of time in minutes. Moreover, Y-Axis represents degrees temperature. Nevertheless, Figure (14), shows only the rate of change for the humidity in order to clarify the information and data correctly, where X-Axis represents the time rate of change and the time in minutes. Moreover, Y-Axis represents the rate of humidity and moisture measured using percentage.

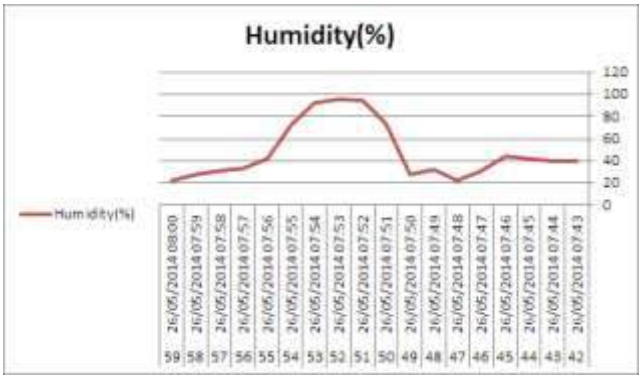

Figure 14. Humidity results

15 CONCLUSION AND FUTURE WORK

In this research, explained the problem arising from the changes in temperature and humidity, which affect the products and cause damage. In addition, it proposed to use a Datalogger, which records the temperature and humidity and converted to graphical (whether temperature Celsius or Fahrenheit). The data logger device helped with treating the problem of the change in temperature and humidity, which causes damage to the product and cause damage to the health of the consumer, by giving accurate readings and temperature and humidity, in addition to (the time and date) since the device activated. Using the data logger device gives this result: the temperature in the freezer dropped to 12.7 °C, and the boiling water temperature 30 °C, the device in outside (regular) gives 36.5 °C temperature.

We aspire to provide a data logger in places Electronics in Kuwait, and that is used in many institutions to maintain consumer protection, in the future we are working on the development of the machine and add other features to increase the efficiency of the device, even help in overcoming the problem of damage to products, consequent consumer protection.

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Smart Taxi Navigation System Using IOS Application Case Study: Kuwait City

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ABSTRACT

Developers around the world always seek to contribute to make life seem easier using technology and communications. Therefore, the technology has become involved in almost all matters of the life, such as communications and transportation, where the transport is always suffering from delays and fraud, especially taxis category. This target group in the project always abound the monument between the passenger and driver operations where prices are floating. In addition, the delay caused by the large number of vehicles on the street and limited transportation paid, lead to the desire to bring this research which contributes to solving many problems such as wasting time and fraud. This paper proposes an application named "TAXICAB" works on the smart mobile phone that uses GPS technology to GPS, and it helps to know all the information for the driver and the advantage of ease of use.

KEYWORDS

Smartphone, data flow diagram, Global Position System GPS, iPhone Operating System IOS.

1 INTRODUCTION

Information technology has become linked to the development of communities in our time and the multiplicity of the most important means for the transfer of developing societies to more sophisticated societies. They contribute directly to building a new society based on electronic information services directly related to the production of communication and education services. Accordingly, highlights the important question centered on whether the information and communication technology offers the ability to develop countries to overcome poverty, and skip the traditional stages of development, and move it into a knowledge-based growth path and has a value of greater added.

It is clear that ICT (Information and Communications Technology) alone is just a tool, and tools are not a substitute for the need for real development. However, the information and communications technology provide tools that development and restructuring acceleration by providing more consistent access to information, as a further people have gained access to more information whenever and wherever they need it. The effect of this is represented profound changes in the structures of markets and organizations and patterns of economic and administrative existing behavior before the Internet age [1].

The term information technology refers to a set of elements and capabilities that are used in data and information collection, storage and dissemination using computers and communications technology at high speed and efficiency to bring something useful to help the development of societies. Information technology has changed the industrial revolution of production system eighteenth century regarding production volume, quality and form of the product, which can be modified based on the customer's request to keep abreast of new developments and technologies.

Information technology is available around us and affect and improve the course of our daily lives (though not our sense of them). They are found in television stations, and institutions of transportation, office automation, financial institutions, agriculture, accounting, education and training, and at home, health, medicine, manufacturing, and the press, energy, sports, and others [2].

During the big revolution in the online world, people are trained to share their thoughts, experiences, and interests on the network. In the

past five years since the launch of the Apple iPhone phone, and the dissemination of its stores around the world, grown applications mobile phones to become a huge market as a result of these electronic revolutions.

Customers are traveling in the Arab world these days to use the smartphone applications for faster access to services companies and entities that are dealing with. Recent studies have demonstrated the importance to be any organization, private company or government agency, or even members of the smartphone application offer the same service provided by the website of the same study, which demonstrated the growing decline in the number of users that.

2 PROBLEM DESCRIPTION

The majority of residents are suffering difficulties in the Arab countries. Residents who do not have a private jet, face difficulties in moving from one place to another, especially because of poor public transport. Taxis are often considered in Kuwait as an easy and convenient transport and sometimes cheap. However, with the presence of more than 65,000 taxies scattered across the country is likely to encounter some of the taxi drivers of others are honest and exposure to the agent fraud more than one way, do not be afraid this does not mean that everyone as well. In fact, the most honest taxi drivers are as follows months we offer you ways to fraud taxi drivers in Kuwait and how to behave in the event of any of them, God forbid.

Go In all over the world and Kuwait City is no exception to this rule, going from roads is logical and long distances more than supposed that might lead to widespread cheating.
As a tourist, the driver assumes that tourist does not know the right way. Thus, he selects the roads longer and bypasses to get to the area you want, and that increase the value of the fare. In case the tourist knows the short way, the driver may give excuses such as the presence of a traffic jam and congestion of the usual route, so he exhibits roads lightest busiest.

Again, to assume that the fare is 2 dinars and you give the driver a sheet of category 5 dinars, here the driver will demonstrate that he is looking for the remaining amount to return 4 dinars. Then he will tell you, unfortunately, do not own exchange or 3 dinars to restore the balance It is expected that you are a tourist, or a citizen or expatriate tolerance will do the rest and thus got three extra dinars for free.

The driver proposal fixed price fare for connection rather than using the counter and will try to convince you that this method is cheaper and better for you because of traffic jams and congestion and it will behave shortcuts to reach as soon as possible. This command is not considered a stunt, but some taxi drivers in Kuwait illusion that they are in the Circuit precedents!

Certainly, they have the experience of leadership in this way where they want to gain time and to get the largest number of customers during the time, in all cases, if you feel you are in danger or that the driver recklessly.

Moreover, usually represents a taxi ride crisis for any traveler with the private exploitation of some foreign drivers not knowing the price of a timely and roads shorter but with the arrival of the application, which provides taxi with determining the exact amount of the trip.

Anyone can request a taxi through this free application easily using GPS technology. GPS in his personal application to be able to locate the user, and the closest taxi available. Then, it sends the location for the taxi driver with high accuracy. The application is easy to call a taxi with costing; also, it is free and secure service where passengers will be able to see the image of the driver on the phone.

The user can follow the taxi path until it reaches the whereabouts and there is no need to tell the driver where the place depends on the location of the service as GPS.

3 RELATED WORKS

J. Yuan, Y. Zheng, X. Xie, and G. Sun, 2013, this paper explains that there is a way to solve all these problems, according to the rules set by the Egyptian Ministry of Interior. For the first time

ever in Cairo, you can choose the driver safely from a large list of authorized drivers, and give him a proper evaluation and comment on his behavior and his way with you to help others to make the right decision [3].

In 2003, Silva, Aloizio P., and Geraldo R. Mateus in their paper presented the idea of private chauffeur service on demand or "smart Taxi" provided by the company "upper" on the user to exploit the application installs on smart devices, and then register for the service by entering their personal data and credit card numbers, and then the user can see his geographical also appear on the map of the company "upper" and scattered cars in the neighborhood with the estimated time of arrival. The user can then click on the screen to ask for a car, and in the case of acceptance of the application, the user can see the car as it moves towards him, and when he arrived to the destination, it can be for passengers to leave the car without paying the freight in cash, because the process is done automatically through the application that deducts the fare from the tally banking [4].

Ali, Yousif Al, Ibrahim Al Kattan, and Meftah Hrairi mention an application that selects the location of the user automatically makes getting a taxi is very easy and convenient. Once the driver confirmed to request the user is notified taxi location immediately. Upon arrival of the car to the place chosen by the user is informed of this as well.
Hla Taxi Dubai is the latest development of the transportation system in the United Arab Emirates is characterized by taxi white and grey, turquoise, where he dedicated most of the tourists through the permanent custody of the vehicle and return to an area Reservation, Reservations can be made through the application on the phone or the website or call the hotline [5].

Awajan, Albara on Sept 2013 discussed the distinguished taxi in Jordan which is the type of Mercedes Taxi system features rows of different roam the streets of the Jordanian capital Amman passenger traveling through the site to locate the nearest passenger satellite and the application on the mobile phone, this limits the application of wasting time searching for passengers [6].

M. Hadi Baaj elucidated the Taxi Beirut which is an application similar to other applications distinguishes this application through that passengers can choose its own specific driver and mobility on demand in addition to pricing Fixed night and day with free charge to the request within Beirut, but in addition, you know symbolic abroad on demand [7].

Anwar, Ayesha, Mikhail Volkov, and Daniela Rus, discussed that getting Taxi new system of practice in the State of Palestine is characterized by a system that exists in most areas of the busiest. In addition, most applications can be for the driver to know the place-bound him passenger through mapping system utter the name (Hot maps) and are characterized by taxis small size and work on the electricity system and gasoline with engines hybrid [8].

4 IMPLEMENTATION

If the user wants to use taxicab services, he/she must have an account by sign up. There are two types of accounts: passenger and driver. Signing up requires filling some information as the first name, last name, mobile number, email address, password and choose the account type of user passenger or driver as shown in Figure 1 for the DFD (Data Flow Diagram) of the application.

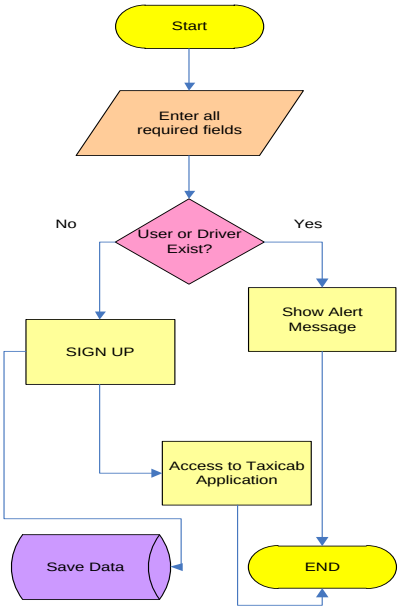

Figure 1. Sign up for the application

When the user needs to reaccess the application, he/she must sign in with entering username and password. After that, the system checks on user authentication then let the user access to the taxicab services, as shown in Figure 2.

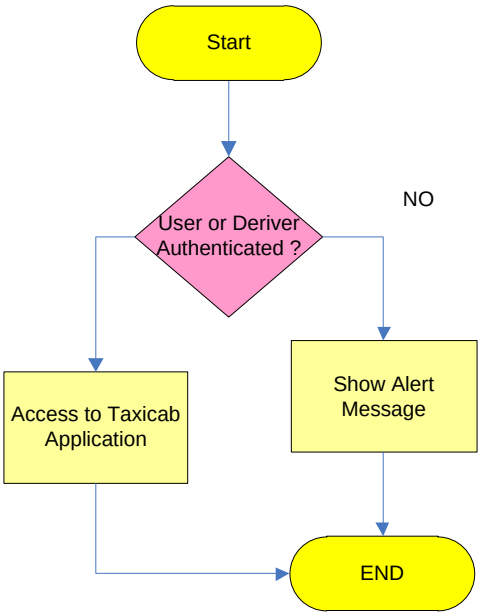

Figure 2. Login the application

On the other hand, if the user forgets the password the user must request the password by entering his email address. The system will check if the user exists or not then send password through email as shown in Figure 3.

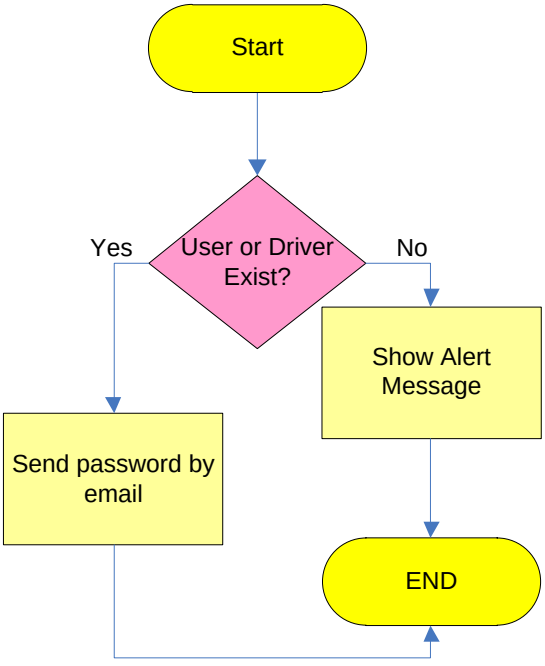

Figure 3. forget the password

Figure 4 explains how the application works and how it finds a taxi for the user. When the user (passenger) access to the taxicab services, the system will check on location services. If the location services not enable, the system will not be able to get user location. The user can enable location services in the mobile settings. On the other hand, if the location services are enabled, the system will be able to find user location on the map.

The second step, the system will request from the user to determine his/her destination on the map then the user needs to make taxi request. The system will calculate the price and the distance between user current location and destination. After that, the user will have all taxi request details. In addition, the user has two choices accept or cancel. If the user chooses to accept, the system will start looking for a taxi.

After the system complete the search process and find the nearest taxi. The system will calculate the estimated time for the driver to pick up the user then view full details about driver and ride. On the other hand, if the system cannot find the taxi on user area. The user has two choices cancel the request or reload the view and try again.

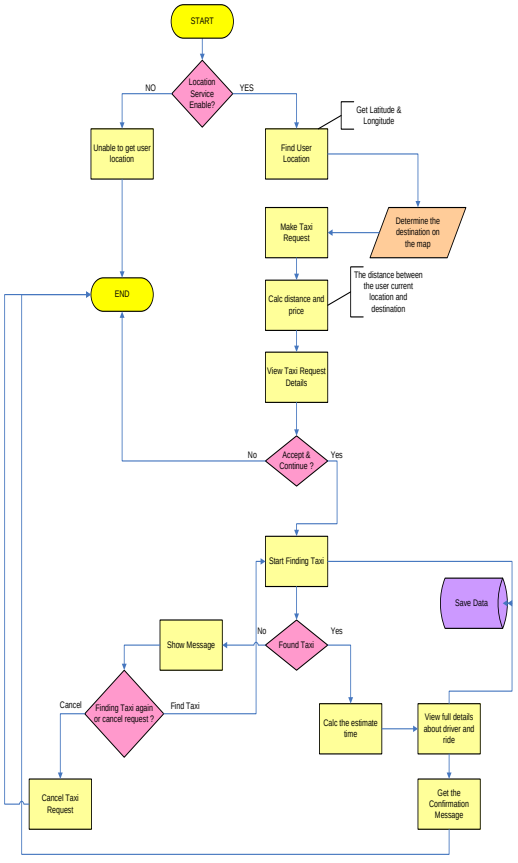

Figure 4. finding the Taxi (Passenger) DFD

On the driver side. The system also will check on location services. If the location services are enabled, the system will be able to determine driver location on the map. If the driver status is busy, the system will be updating the driver location on the database, but if the user status is available, the driver will be able to get taxi request. If the driver gets the taxi request from the system, the status will be changing to busy; the red pins will be set on driver map to determine the passenger current location and destination. Finally, the driver will be able to display taxi request details. Figure 5 shows that clearly.

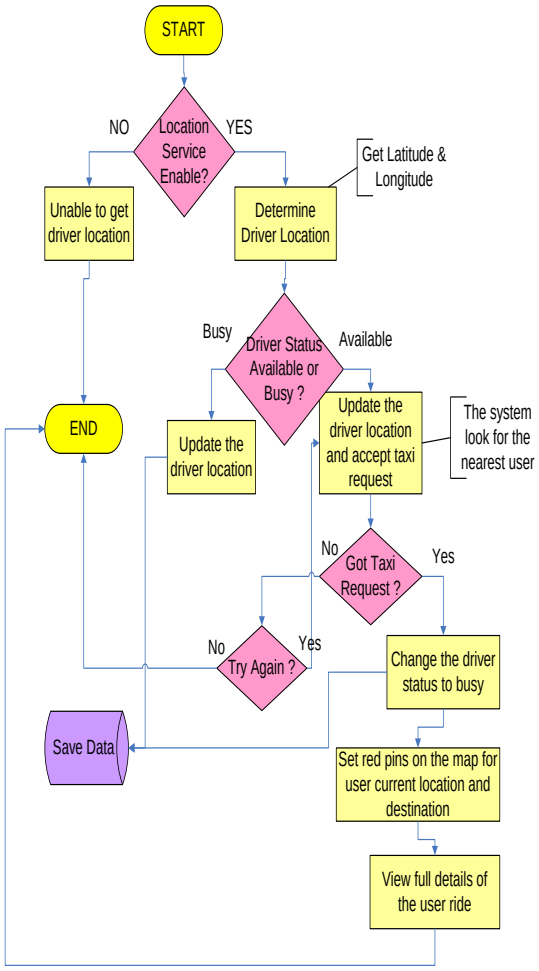

Figure 5. Getting Taxi Request (Driver) DFD

5 TAXICAB DESIGN

The screenshots of the application it this paper to let the reader know the UI of the application and how its work in the mobile. In this application, the UI designed in a friendly way to make dealing with application easier and to make the application more powerful.

As shown in Figure 6 the user can log in to taxicab by username and password after the user had been signup in the application. Additionally, the user can press the Forgot Password button for password reminder or press Sign up button in the right upside for the register.

Figure 6. Login screen

To sign up, the user must press Sign Up button to enter Login screen. As shown in Figure 7 the user signs up by entering the required information (first name, last name, mobile number, Email address and password). In addition, the user must choose one of the application account type (User / Driver) and that by press “Account Type” which moves the user to the Account Type screen (Figure 8). After choosing an account type, the user should press back button to complete sign up.
Then the user should press tick button (in sign up screen) to complete sign up process and access to the taxicab service. The user can return to the Login screen by press the “back” button.

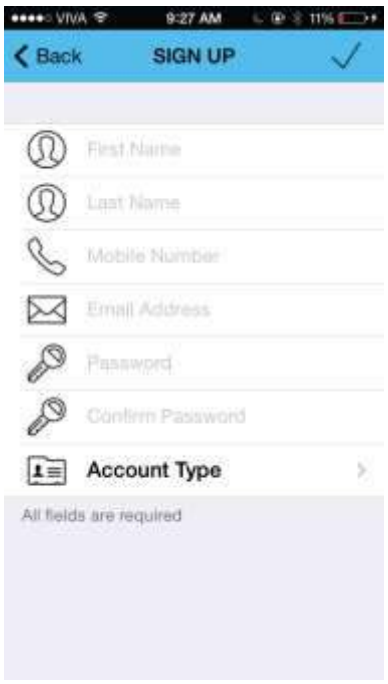

Figure 7. Sign Up screen

Figure 8. Account type screen

As shown in Figure 9, if the user forgets the password the user can request it by pressing "Forget password?" button which moves the user to the "Password" screen. In this screen, the user should enter the email address that is had been registered in the database of the application. After that, the user press on tick button and he/she will receive an email with the password.

Figure 9. Password screen

Figure 10 shows the map screen, which is showing the current user location by a black dot on the map and latitude/longitude values. If the user wants to make taxi request, he/she must make a long press on the map to determine his/her destination then press Make Taxi Request button. The user also can press log out button to return to the login screen.

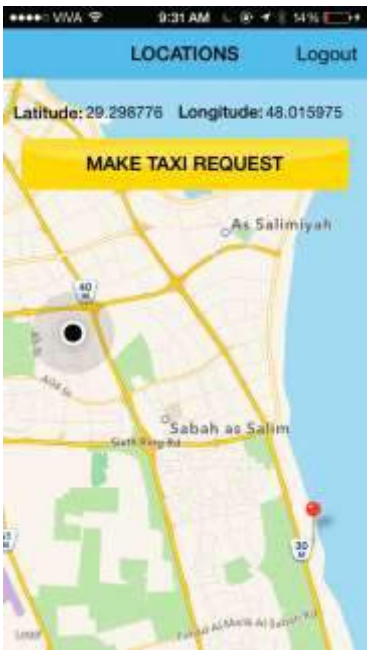

Figure 10. User Location screen

As shown in Figure 11, after pressing on Make Taxi Request in the previous screen, the system

in taxicab determines country, state, current user location, user destination, the distance between user current location and user destination.
Therefore, the system calculates the price (Price = (Distance in KM * 0.5) + 2 KD). The user for sure can accept this offer and continue on this process, or press on cancel button and return to location screen.

Figure 11. Taxi Request details

Figure 12 shows the request progress screen. The user should wait for 20 sec until he/she get the respond (find a taxi or no taxi found). If the system cannot find a taxi in 20 seconds, the user has two choices. The first choice is pressing on the "cancel request" button and return to the location screen. The second choice is pressing on the "reload" button and try again to find a taxi.

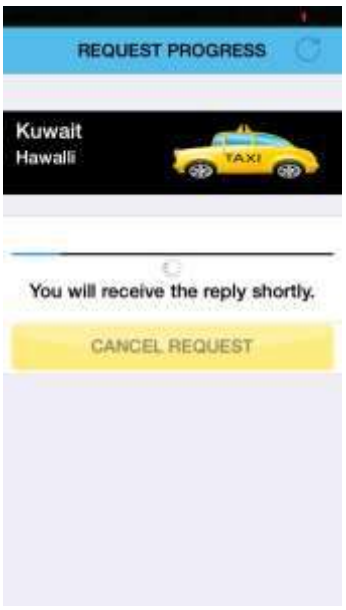

Figure 12. Request Progress screen

After completing the search process in the previous screen and find the nearest taxi. The system will display all taxi request details and calculate the estimated time for the driver to pick up the user (Estimated Time = ((Distance between user and driver in KM * 2) + 2)). After that, the user should press the continue button to complete the process. That shown in figure 13.

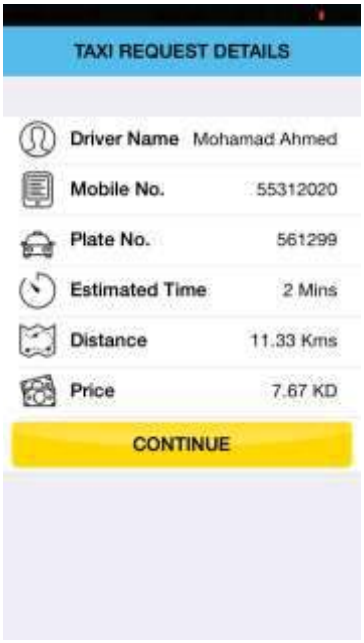

Figure13. Taxi Request Details screen

In figure 14, the user gets the confirmation with the estimated time for pick up. The user can press the main button to return to the location screen or press the logout button.

Figure 14. Taxi request Confirmation

In Figure 15, the driver location screen shows the current driver location by a black dot on the map and latitude/longitude values. Additionally, it shows the status of the driver (Available or Busy). On this screen, the driver can press on reload button on the right upside to update his location and find taxi request. He can also press on logout or change his status (Busy if the driver cannot accept any taxi request or Available if he is ready to accept for taxi request).

If the Driver status is available and someone makes taxi request, the driver might receive the notification message to let him know that there is a taxi request. Additionally, two red pins will show on the map to determine user current location and user destination. After the driver got taxi request, he can press the taxi request details button to find out the taxi request details.

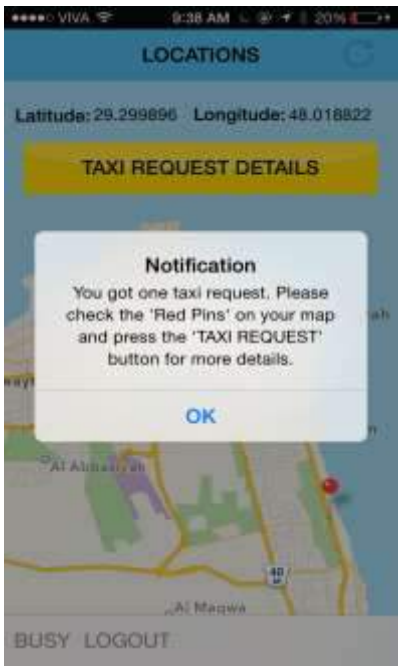

Figure 15. Driver Location screen

In the previous screen, if the driver presses on the “OK” button to show the taxi request details, the system will display all taxi request details (country, state, current user location, user destination, price and estimated time). As shown in Figure 16

Figure 16. Taxi Request Details screen

6 RESULTS

After this application selects the location of the user automatically makes getting a taxi is very easy and convenient. Once the driver's

confirmation of the request, the user is notified with immediately taxi location. Upon the arrival of the car to the place chosen by the user is informed of this as well, users will be able to allow the driver the RTA to get direct feedback from users and increase their level of satisfaction with the service performance evaluation. Offers the user a simple model of five points to evaluate the performance of the driver after the trip ends. The application serves as a channel of communication smart characterized simply infinite and keep pace with the modern techniques and serve a broader includes all segments of society and takes into account the needs and aspirations. Moreover, this smart application makes a book a taxi a new type of luxury and excellence provided for all in the State of Kuwait, that smartphone users can download the software on their phones through the Apple Store on the iPhone and phones in the Play Store on the Galaxy phones.

7 CONCLUSION AND FUTURE WORK

The application of smart taxi is one of the most important services and the latest smart applications development and most recently will be launched. The application is the first of its kind, which gives the possibility to book taxis, tracking and arrival paths, also allows users to book a taxi in Kuwait at the touch of a button at any time and from any place where is easy to use.

The new application covers all taxis in Kuwait, and more than 65,000 cars travel. Additionally, that the application is able to pick up the title automatically and recognize the passenger's location, which will help to identify the title, without the need for details and data may be difficult in some cases to some elderly or tourists.

Will also launch the second version of the application taxi smartphone compatible with smartphones, which allows the introduction of new services to customers, including payment of traffic fines, and the introduction of credit cards in advance for discount fares, as well as it includes services in Kuwait Guide, available in Arabic and English, is available on the platform Play Store, Apple Store.

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A 3-Dimensional Object Recognition Method Using SHOT and Relationship of Distances and Angles in Feature Points

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ABSTRACT

In recent years, a human support robot has been receiving attention. This robot is required to perform various tasks to support humans. Especially the object recognition task, which is important when people request the robot to transport and rearrange objects. Object recognition methods, especially using the 3D sensor are also receiving attention. As conventional object recognition methods using 3-dimensional information, Signature of Histogram of OrienTations (SHOT) is commonly used. SHOT performs highly accurate object recognition since SHOT descriptor is represented by 352 dimensions. However SHOT misrecognizes objects which have the same feature but which are not the same objects and if there is occlusion in the 3-dimensional object. As a solution, I would like to propose the object recognition method with high quality by using the positive part of SHOT.

KEYWORDS

Cognitive system, 3D object, SHOT descriptor, List matching, Human Support Robot

1 INTRODUCTION

In recent years, human support robots have been receiving attention [1] [2].
Especially, objects recognition task is important in case that people request the robots to transport and rearrange an object. We consider that there are five necessary properties to recognize in domestic environment as follows.

(1) Robustness against occlusion
(2) Fast recognition
(3) Pose estimation with high accuracy
(4) Coping with erroneous correspondence
(5) Recognizing objects in a noisy environment

Firstly, the robots need the robust recognition for occlusion because occlusion occurs between different objects in domestic environment. Secondly, the robots need to recognize a target object fast to achieve required tasks fast. Thirdly, the robots need to estimate a pose of a target object with high accuracy to manipulate a target object. Fourthly, the robots need to cope with erroneous correspondence to recognize objects which have the same feature in a local region but which are not the same object. For example, a cube and a rectangular they both have same future points in their vertex, but aspect ratio is totally different.

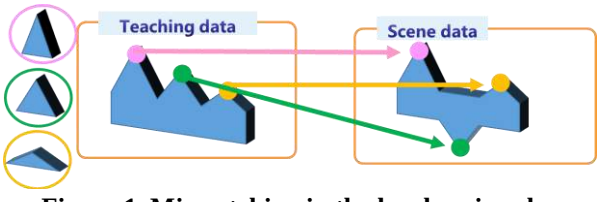


Figure 1. Mismatching in the local regions by using SHOT

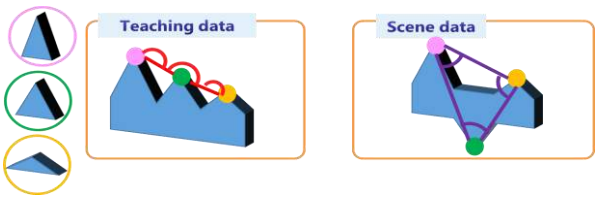


Figure 2. The relationship between the feature points by previous research

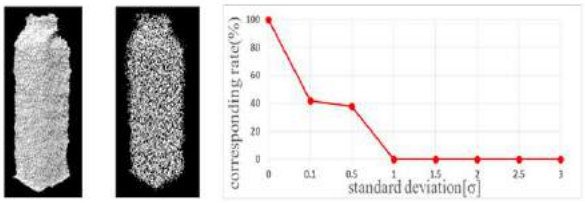


Figure 3. The changing of the correspondence rate

Table 1. Properties of conventional methods and the proposed method

	Robustness against occlusion	Fast recognition	Pose estimation with high accuracy	Coping with erroneous correspondence	Recognizing objects in a noisy environment
SHOT	×	○	○	×	○
Previous research	○	○	○	○	×
Proposed method	○	○	○	○	○

Finally, the robots need to recognize an object which has some noises.

As conventional object recognition methods using 3-dimensional information, Signature of Histogram of OrienTations (SHOT) is commonly used [3] [4].

SHOT focuses on the local region and expresses the relationship between the point of interest and the surrounding points as SHOT descriptor in a histogram. SHOT performs highly accurate object recognition since SHOT descriptor is represented by 352 dimensions. Therefore if there is some noise, value of shot descriptor is hardly interfered. But SHOT misrecognizes objects which have the same feature but which are not the same objects, because SHOT only focuses on Local feature points to match objects as shown Figure 1. Therefore if an object has same features in local, SHOT incorrectly recognizes as same objects.

Therefore, to compensate for the defect of SHOT, our laboratory has developed the previous research for the object recognition by Maehara et al [5]. The previous research used some high curvature points in regions for feature points. Furthermore the previous research generates a list by listing relationships of distances and angles between feature points and matches lists as shown Figure 2. Thereby, the previous research estimates a pose of a target object with high accuracy and copes with erroneous correspondence by using not only the feature points but also relationships between feature points.

However, the previous research does not satisfy recognizing objects in a noisy environment. Figure 3 shows the corresponding rate when we added Gaussian noise according to standard deviation, and shows the result of matching the scene data with noises with its original data. In the Figure 3, we added noises on the data of the pack. As you can see, corresponding rate is gradually decreasing, therefore the previous research is easily interfered by noise. The calculation method of corresponding rate will be shown in the section 2.7.

Table 1 shows properties of these methods. As I mentioned, two of the method do not satisfy all the properties. To satisfy all the properties of recognition, we propose a 3-dimensional object recognition method by using SHOT and relationships of distances and angles in feature points. We use the positive parts of both SHOT and previous research. As our approaches, firstly, to have the robustness against noises, the proposed method uses SHOT in region to extract feature points. SHOT focuses on the local region and expresses the feature amount in the histogram as SHOT descriptor when extracting feature points. For this reason, it is conceivable that they are less likely to interfere with noise since feature points are determined by the values of the histogram. Furthermore, the proposed method generates the list of distances and angles between extracted corresponding points that SHOT descriptors are matched. In addition, the proposed method matches lists which are generated in the model data and scene data.

2 PROPOSED METHOD

2.1 Flow of The Proposed Method

In this section, we describe about an overview of the proposed method based on its processing flow as shown Figure 4.

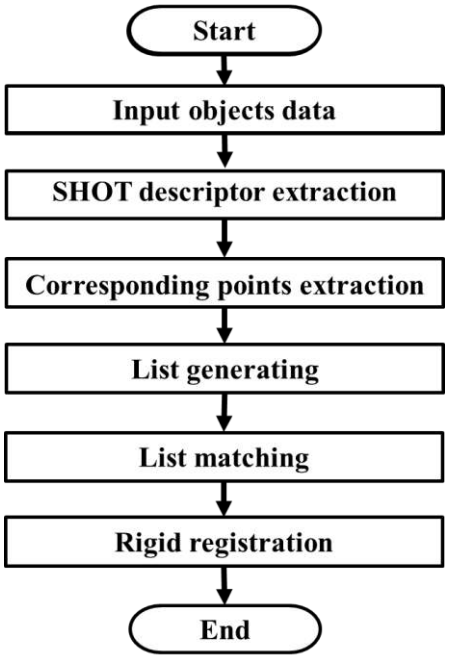
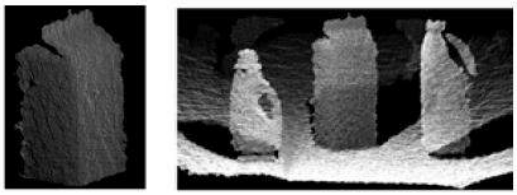


Figure 4. The flow of the proposed method



(a). model data **(b). scene data**

Figure 5. The input data

2.2 Input Object Data

Firstly, the proposed method inputs target objects as a teaching data and a scene data as shown Figure 5.

2.3 SHOT Descriptor Extracting

To extract feature points, the proposed method uses SHOT (Signature of Histogram of Orientations). The surface features of the three-dimensional model can be described with unique and repeatability by using SHOT. It expresses the relationship between the point of interest and its surroundings by histograms. Since SHOT descriptor is expressed in 352 dimensions, SHOT is the method that can extract feature points with high accuracy. In this section, we explain about how to extract a SHOT descriptor. To extract a SHOT descriptor, we use an isotropic spherical grid that encompasses partitions along the radial, azimuth and elevation axes, as sketched in Figure.1. Since each volume of the grid encodes a very descriptive entity represented by the local histogram, SHOT can use a coarse partitioning of the spatial grid and hence a small cardinality of the descriptor. In SHOT, the angle of the dot product of the normal vector of the reference point and the normal vector of the point of each grit is represented by histograms.

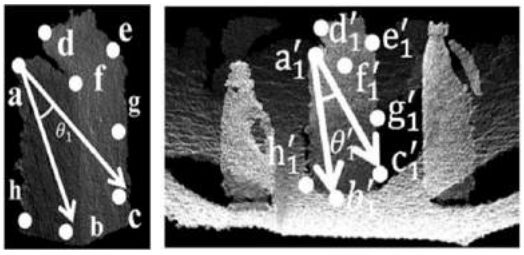
2.4 Corresponding Points Extraction

To match the SHOT descriptor, the proposed method matches each scene feature against all model features. Furthermore, the proposed method computes the ratio between the nearest neighbor and second best. If the ratio is below a threshold, a corresponding is established between the scene feature and its closest model feature.

2.5 List Generating

In the list generating process, the proposed method generates the list of distances and angles between extracted corresponding points as relationships of these points.

At this time, the proposed method extracts the combination of three points as much as



(a). In the model **(b). In the scene**

Figure 6. Overviews of matched points

Table 2. The LIST in the model

number	corresponding point①	corresponding point②	corresponding point③	distance between point ① and ②	distance between point ① and ③	angle
1	a	b	c	l_{ab}	l_{ac}	θ_1
2	a	b	d	l_{ab}	l_{ad}	θ_2
3	a	b	e	l_{ab}	l_{ae}	θ_3
⋮	⋮	⋮	⋮	⋮	⋮	⋮
56	f	g	h	l_{fg}	l_{fh}	θ_{56}

Table 3. The LIST in the scene

number	corresponding point①	corresponding point②	corresponding point③	distance between point ① and ②	distance between point ① and ③	angle
1	a'	b'	c'	$l_{a'b'}$	$l_{a'c'}$	θ'_1
2	a'	b'	d'	$l_{a'b'}$	$l_{a'd'}$	θ'_2
3	a'	b'	e'	$l_{a'b'}$	$l_{a'e'}$	θ'_3
⋮	⋮	⋮	⋮	⋮	⋮	⋮
56	f'	g'	h'	$l_{f'g'}$	$l_{f'h'}$	θ'_{56}

possible in the corresponding points as shown Figure 6, Table 2 and Table 3. In recognizing the object, the proposed method is able to be less mismatching of list elements since the lists we generated are including all the corresponding points by matching SHOT descriptor, furthermore if there is a point that is mismatched by SHOT matching, the proposed method is able to exclude that point from matching targets due to the difference in the three points relationship.

2.6 List Matching

In the list matching process, the proposed method matches the list of the model data and the list of the scene data. As shown in Figure 6, Table 2 and Table 3, a list has distances and an angle as element. Then, the proposed method matches between list number 1 of the model and all the lists of the scene data. Furthermore, in the proposed method, the list with the smallest difference of between the sum of distance between point① and point②, distance between point① and point③ and angle, which is less than the threshold is subjected to matching.

2.7 Rigid Registration

To recognize the target object in the scene data, the proposed method applies the rigid registration to the teaching data. Firstly, the proposed method fits the teaching data to the matched object in the scene by calculating the optimum rotation matrix R and the translation vector t from associated corresponding points. Secondly, the proposed method calculates a corresponding rate M between a teaching data and the matched object by using

$$score = \sum_{i=1}^{N} f\left(\min\{dist_{ij} | 1 \le j \le L\}\right), \quad f(x) = \begin{cases} 1 & (x \le \boldsymbol{th}_c) \\ 0 & (x > \boldsymbol{th}_c) \end{cases}, \quad dist_{ij} = \|\boldsymbol{p}_i - \boldsymbol{q}_j\|, \tag{1}$$

$$M = \frac{score}{L} \cdot 100. \tag{2}$$

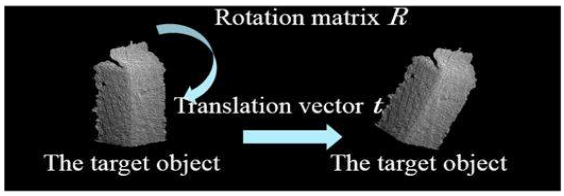


Figure 7. Illustration of the rigid registration

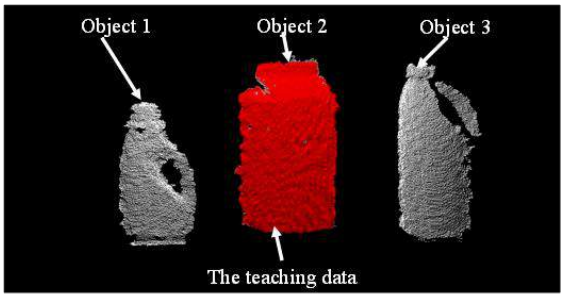


Figure 8. The result of the rigid registration

Where, N is the number of points of the teaching data. L is the number of points of the object in the scene. $\boldsymbol{p}_i$ is matched point of the fitted teaching data. $\boldsymbol{q}_j$ is matched point of the matched object in the scene. The proposed method counts a number of $\boldsymbol{p}_i$ which are within a threshold $\boldsymbol{th}_c$ which is 1 [mm] of $\boldsymbol{q}_j$ by the equation (1) as a score. And then, the proposed method calculates the corresponding rate M based on the score by equation (2). Finally, the proposed method selects a clustered object which has the highest corresponding rate.

3 EXPERIMENTS

In this section, to evaluate effectiveness of the proposed method, we compare the proposed method with the previous research about five properties mentioned in section 1 as follows.

(1) Robustness against occlusion
(2) Fast recognition
(3) Pose estimation with high accuracy
(4) Coping with erroneous correspondence
(5) Recognizing objects in a noisy environment

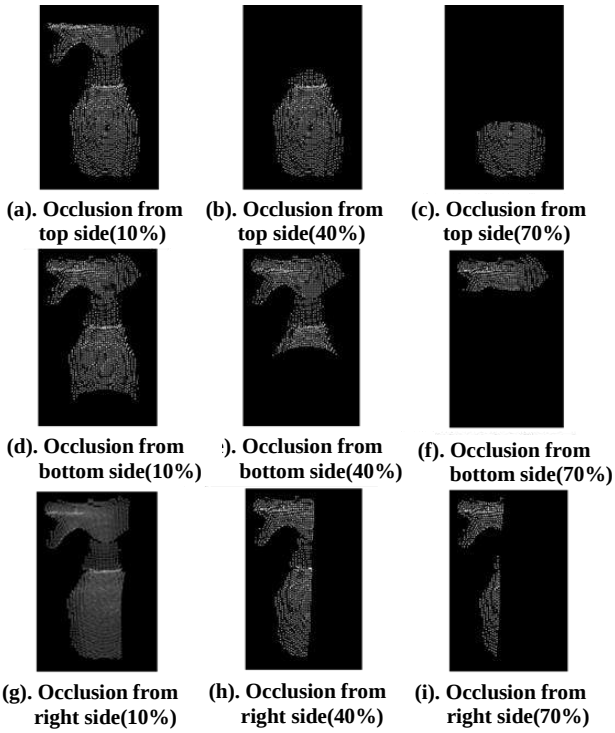
3.1 Object Recognition in Occlusion Scene

In this experiment, we compared the proposed method with the previous research and SHOT to evaluate about three properties as follows.

(1) Robustness against occlusion

(a). Pack (b). Spray (c). Cup noodle

Figure 9. Overviews of objects and 3-dimensional data of objects in the experiment



(a). Occlusion from top side(10%) (b). Occlusion from top side(40%) (c). Occlusion from top side(70%)

(d). Occlusion from bottom side(10%) (e). Occlusion from bottom side(40%) (f). Occlusion from bottom side(70%)

(g). Occlusion from right side(10%) (h). Occlusion from right side(40%) (i). Occlusion from right side(70%)

Figure 10. The examples of occlusion scene of the spray

(2) Fast recognition

(3) Pose estimation with high accuracy

We used three actual objects as recognition targets which are usually in domestic environment and obtained those 3-dimensional data with Kinect as shown in figure 9. In Figure 9, (a) shows a pack, (b) shows a spray and (c) shows a cup noodle.

To generate occlusion scenes, we delete part of each 3-dimensional object data from 3-directions (top, bottom and right side) by 10% each of point number of each 3-dimensional object data as shown in figure 10.

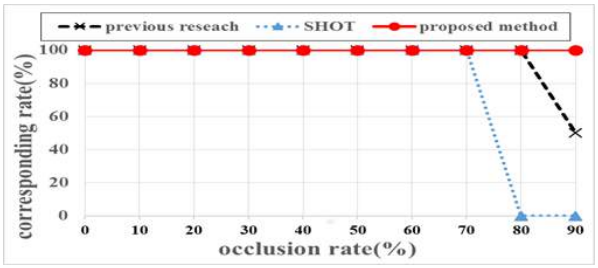
To evaluate a pose estimation accuracy of a target object, we use the corresponding rate M between the target object fitted by using the optimum rotate matrix R and the translation vector t mentioned in the rigid registration process (section 2.7). To calculate the corresponding rate M as a pose estimation

Table 4. The result of average processing time

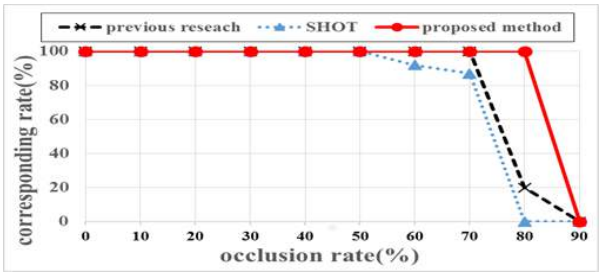
	Average processing time[Sec.]		
	Spray	Pack	Noodle
Previous research	1.29	1.29	1.70
SHOT	1.25	1.26	1.70
Proposed method	1.34	1.54	1.89

accuracy, we use the equation (1) and (2) with th_c which is 1 [mm]. In case that, the corresponding rate is high, that means methods estimate the pose of a target object with high accuracy. On the contrary, in case that, the corresponding rate is zero, which means methods mismatch the target object. The reported processing time is obtained using Intel(R) Core(TM) i5 3.1GHz with 8.0 GB of main memory.

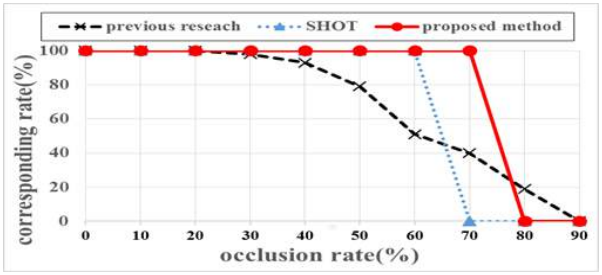
Figure 11 shows the result of occlusion scenes for the spray object. As shown Figure 11, the proposed method was able to recognize objects nearly equal to the previous



(a). Corresponding rate of the spray occluded from the top side



(b). Corresponding rate of the spray occluded from the bottom side



(c). Corresponding rate of the spray occluded from the right side

Figure 11. The result of the spray occluded from 3 directions

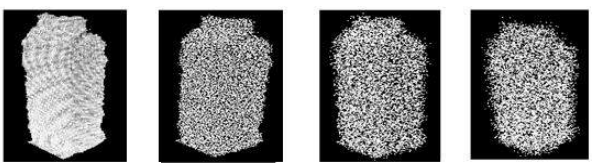
research and SHOT in occlusion scene. In addition, as shown in Table 4, a processing time of the proposed method was nearly equal to the SHOT and the previous research. From these results, we consider that the proposed method has the robustness against occlusions because the proposed method is able to match the feature points of the target object and the feature points of unoccluded scene data by using the SHOT. In addition, we consider that the proposed method is able to estimate a pose of a target object with high accuracy because the proposed method uses is not only the corresponding points but also relationships between corresponding points. In this paper, I only show the result of the spray, however we got the same result in other objects.

3.2 Recognizing objects in a noisy environment

In this section, to evaluate effectiveness of the proposed method in recognizing objects in a noisy environment. We prepared same objects with the first experiment. To generate noisy scenes, we added some Gaussian noise on the scenes. Figure 12 shows the changing of the scene data when we added noises.

To evaluate a pose estimation accuracy of a target object, we use the corresponding rate M same as section 3.1.

Figure 13 and Table 5 show results about accuracy and processing time of the proposed method, SHOT and the previous research. As shown the result, we consider that the accuracy and processing time of the proposed method are equal to or more than these of the previous research and SHOT. Although I show only the result of the spray here, the pack and the Cup noodle were able to obtain equivalent result.



(a). 0.001[σ] (b). 0.002[σ] (c). 0.003[σ] (d). 0.005[σ]

Figure 12. The result of the spray occluded from 3 directions

Table 5. The result of average processing time

	Average processing time[sec.]		
	Spray	Pack	Noodle
Previous research	3.20	2.75	2.62
SHOT	1.24	1.09	1.12
Proposed method	1.82	0.91	1.24

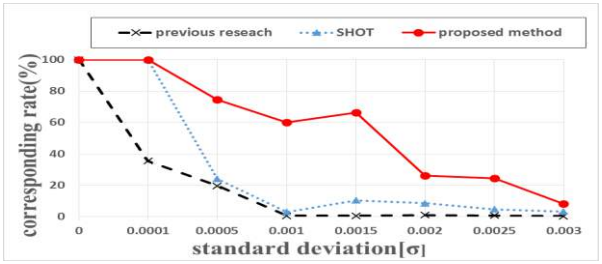


Figure 13. The result of the spray of the pose estimation in a noisy environment

From these results, we consider that the proposed method has the robustness against noises, because the proposed method uses SHOT to generate feature points, SHOT is hardly interfered with noises due to the high dimensionality of SHOT feature quantities.

3.3 The Experiment in Recognition of Objects Which Have the Same Feature but Which are not the Same Object

To qualitatively evaluate about coping with erroneous in the proposed method, we compared the proposed method with the SHOT. As target objects which have the same feature in a local region but which are not the same object, we prepared a 500ml-pack and a 1000ml-pack as shown in Figure 14.

We generated the teaching data from the 1000ml-pack and applied the proposed method, the SHOT to a scene data in 500ml-pack. Figure 15 and Figure 16 show the results of the SHOT, Figure 17 shows the result of the proposed method. As shown in these results, erroneous correspondence occurred in the SHOT and it misrecognized the 1000ml-pack as the 500ml-pack.

(a). 500-ml pack (b). 1000-ml pack

Figure 14. Overviews of objects and 3-dimensional data of objects in the experiment

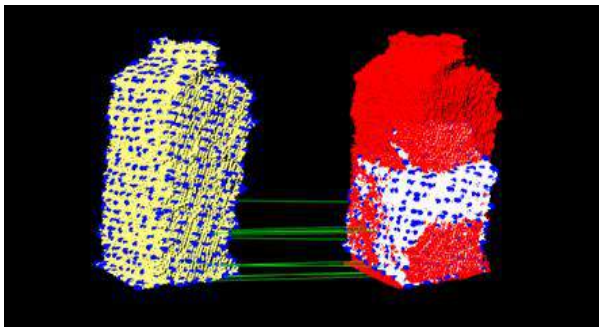


Figure 15. The result of SHOT

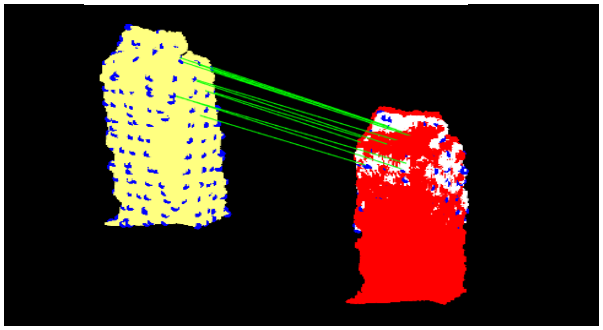


Figure 16. The result of SHOT

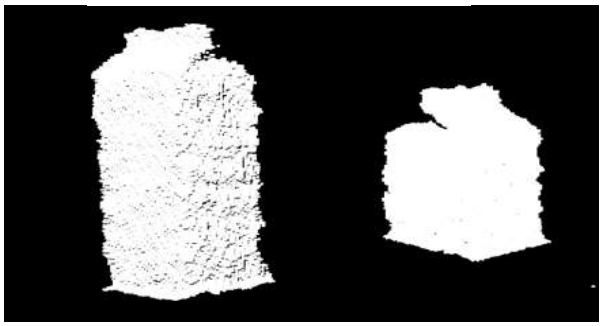


Figure 17. The result of the proposed method

Since the feature quantities of the upper part and the lower part of the pack are exactly the same, when matching is performed, different results are obtained each time depending on a threshold value.

Conversely, the proposed method recognizes that they are the different object since there is no corresponding lines, which means the relationship of distances and angles between points is no corrected. From these results, the proposed method is able to cope with erroneous correspondence and is more effective than SHOT.

4 CONCLUSION

In this paper, we proposed the 3-dimensional object recognition method which has five properties as follows using relationships of distances and angles in feature and SHOT descriptor points for the human support robot.

(1) Robustness against occlusion
(2) Fast recognition
(3) Pose estimation with high accuracy
(4) Coping with erroneous correspondence
(5) Recognizing objects in a noisy environment

In experiments about five properties, we saw the proposed method is more effective than the SHOT and the previous research. Summarizing the above, the proposed method extracts the matching candidate points using SHOT, focuses on the relationship between the candidate points, and eventually uses the list to match.

As a result, it becomes possible to recognize objects that could not be recognized by conventional methods that have been used up to now with high accuracy.

However, the proposed method cannot recognize same shape objects which has different texture because the proposed method only uses SHOT descriptor which are calculated from a shape data of objects. Therefore, as future works, I improve the proposed method by using not only a shape data of objects but also color features in a future work.

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