Version No. :	00
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Effective Date :	1st April 2017

PROFILE OF FINAL REPORT
RAGS

Important Notes

- *Profile of Final Report is to be submitted to declare the project is completed.*
- *Full Report should be uploaded through IREP.*
- *All reports must be based on the actual findings of the reported project.*

Guidelines for writing the Profile of Final Report

- *Report should be written in 'Times New Roman 12' Font, with 1.5 line spacing*
- *Report should be 5 pages (excluding appendices/references)*
- *Report must be in English (Applicable for Research in Arabic as well)*

Project ID/Title : THE INVESTIGATION ON ARABIC WORD POSE ESTIMATION ALGORITHM AS MARKER FOR AUGMENTED REALITY APPLICATION

Project Sponsor : KEMENTERIAN PENDIDIKAN TINGGI

Author Name(s) : DR. MALIK ARMAN BIN MORSHIDI

Department/Kulliyyah/Institute/Centre: ELECTRICAL AND COMPUTER ENGINEERING, KULLIYYAH OF ENGINEERING, IIUM GOMBAK

Research Summary and Findings

Arabic words recognition technique for pattern matching requires a robust and fast technique to be applicable in various application. This research investigates which recognition technique suits better in matching an image of printed Arabic text. The recognition algorithm involves the conventional Scale-Invariant Feature Transform (SIFT), Speeded Up Robust Features (SURF) and Oriented FAST and Rotated BRIEF (ORB). A parameters estimator of model algorithm is used to weed out the outlier point of matching images. The test demonstrates on the Arabic word images with the different angles, scales, and viewpoints. We evaluate the performance through analyzing the matching accuracy rate and computational time.

The three algorithms have been tested on a set of Arabic character image from different angle and scale. The performance evaluation would differentiate the sensitivity of classical SIFT, SURF, and ORB against rotation, scaling and viewpoint. The algorithm used MSAC, which is a variant of RANSAC algorithm, to weed out false matching points. The inliers between two images were found after estimating the geometric transform from matching point pair.

26 different set of Arabic words were used in the experiment. Meanwhile, 100 trials were run for each test. SURF shows more matches than SIFT for almost all words. While ORB presents the least number of matches. The word label 12 and 14 show similar result for SURF and SIFT as they have similar word structure, as label 12 is ‘iyyaka’ and label 14 is ‘waiyyaka’. The performance was evaluated by determining the average matching accuracy rate and computation time regardless of changes. Noting that, for all the experiments, the test is worked on a computer that has 2.40 GHz and 8 GB RAM, with Windows 10 as an operating system.

Rotation

We considered 23 value of degree rotation from 15 degrees to 345 degrees to the word images. The test was conducted using SIFT and SURF algorithm only, since ORB unable to give a reliable result. The matching accuracy rate was calculated by dividing the inlier points value of rotated image with the original matches.

The rotation angle at 90, 180 and 270 degree shows the highest matching rate for both algorithms with SURF leading the accuracy rate with 96% on that three angle. As 90 degree is the reflex angle of 270 degrees, they produce a similar result. SURF demonstrates a better accuracy rate compared to SIFT despite the rotation changes. The overall computation time of SURF is faster than SIFT. For word label 6 and 19, the computing time in SIFT is too high

compared to the computing time in SURF, it is due to the less of data collected for SURF caused by undetected inlier points.

Scaling

In scaling process, we scaled down the word images from 0.9 to 0.8 to observe the effect of scaling to the matching. For 0.9 scale changes, SIFT is shown as the highest matching rate among all three algorithms, while SURF presents the highest accuracy rates for 0.8 scale. Similar to rotation angle experiment, the scaling test shows that SURF is faster than SIFT. In spite of that, ORB taking the least execution time than the others.

Viewpoint

The viewpoint changes were portrayed in four different views; from the above, below, left and right of the Arabic word images. SURF shows the highest accuracy rate for overall viewpoint, while ORB and SURF are shown as the equally lowest matching rate. For down and right viewpoints, ORB presents a better accuracy rate compared to SIFT with 41.19% and 40.63%. For the average computing time, SURF is shown as the fastest computational time compared to ORB and SIFT. Although ORB was believed to be the fastest among other algorithms, ORB shows a poor performance in this viewpoint study. This condition happened due to the extra time is taken in finding the correct interest points for the word images caused by unreliable original interest point.

In this research, we compared the performance of SIFT, SURF, and ORB with MSAC using the different angle of rotations, scales, and viewpoints on Arabic word images. MSAC shows better results after comparing it to RANSAC and LMeds. Then, for rotation and viewpoint changes study, SURF has shown the highest matching accuracy rate. Meanwhile, in scale changes, SIFT have the most stable accuracy rate. In general, SIFT detects more interest points than SURF and ORB in the original images. However, SURF shows a better accuracy rate compared to another algorithm.

For computing time analysis, ORB is taking the least execution time compared to SURF and SIFT despite the changes in scales. However, SURF appears to have the fastest computing time for different viewpoints of Arabic word images due to the unreliable interest point detected in ORB. For further improvement, the experiment could be tested on other new detector and descriptor; Accelerated KAZE (AKAZE) and Learned Arrangements of Three Patch Codes (LATCH), to observe the effect on the distorted Arabic word images.

Arabic Words Pose Estimation Using Infinitesimal Plane-Based Pose Estimation investigates which combination of matching technique with Infinitesimal Plane-Based Pose Estimation (IPPE) that suits better in estimating the pose of Arabic text images. Affine Scale-Invariant Feature Transform (ASIFT) and Speeded Up Robust Features (SURF) matching algorithms are used in this research. The experiment is demonstrated on Arabic word images with different angles of viewpoints. We evaluate the performance through analyzing the matching accuracy rate and how it affects the pose estimation. The algorithms are tested on a list of dataset chosen from a few words within Surah Al-Fatihah in the Quran.

The algorithm has been tested on a set of Arabic word images from left and right perspective at a different angle. The performance evaluation would differentiate the sensitivity of ASIFT and SURF against viewpoint with IPPE framework for pose estimation algorithm. As for SURF, a Lowe's ratio test was used for rejecting bad matches which are similarly used in SIFT. Later, the algorithm used random sample consensus (RANSAC) with inlier threshold set to 0.0075, to weed out false matching points. Using the inlier information, a perspective IPPE were generated to get an IPPE pose and refined pose structure using Levenberg-Marquardt.

We use an experiment setting similar to IPPE framework where a perspective camera is arranged. While a planar model is fixed and projected into the camera's image. The model is a zero-centered square region on the plane $z = 0$ with variable width w. 8 out of 26 different set of Arabic words were used in the experiment as shown in the Appendix. The Arabic words were randomly chosen for this experiment are words label 3, 4, 8, 15, 18, 22, 24 and 26. Meanwhile, 100 trials were run for each test. The performance was evaluated by determining the average matching accuracy rate regardless of changes. Noting that, for all the experiments, the test was done on a computer that has 2.40 GHz and 8 GB RAM, with Windows 10 as an operating system.

We considered six values rotation angles from 10 degrees to 50 degrees from camera perspective to the printed Arabic words images. The matching accuracy rate was calculated by dividing the inlier points value of the perspective image with the original interest point matches. Later, the homography and IPPE are calculated and visualized.

Overall, ASIFT shows higher accuracy rate compared to SURF. However, SURF managed to outperform ASIFT in the crucial camera angle of 50 degrees from left image since at label 8, 18, 22 and 26 from a left perspective, failed to show any value. ASIFT also showed a perfect score of accuracy rate for a few text image; label 22 of L30, label 26 of L26, label 8 of R30, label 8 of R50, label 18 of R50 and label 26 of R40. These results are impossible to achieve

when we consider the condition of input images from the dataset that contain noise. However, the pose estimation could visualize a good pose estimation.

For a pose estimation of 20-degree camera perspective with a similar accuracy rate of SURF and ASIFT which are 70.63% and 78.58% respectively. The visualization of camera pose present a parallel result even though ASIFT collect less interest point compared to SURF. Meanwhile, the difference of accuracy rate for almost 40%, demonstrates that SURF visualizes the IPPE and refined IPPE camera pose better than ASIFT. While SURF tested on 40-degree image, still get to determine the origin and axes pose, ASIFT failed to estimate the pose. These results prove that accuracy rate does not determine the success of IPPE pose estimation and despite ASIFT shows a higher accuracy rate compared to SURF, SURF perform better in visualizing the IPPE camera pose and refined IPPE camera pose. This condition might be happening because of the lack of strength and number of interest points detected before computing the pose.

In this research, we compared the performance of ASIFT, SURF with IPPE framework using the different angle viewpoints on Arabic word images. Generally, ASIFT shows a better accuracy rate than SURF. However, after we display the IPPE and refined IPPE camera pose, SURF shows a better result compared to ASIFT. These results signify that good IPPE pose does not rely on the accuracy rate of matching inliers with original interest points. For further improvement, the experiment of IPPE framework could be analyzed and tested on other words label to observe the effect on pose estimation.

Financial Report and Asset Report

FINANCIAL SUMMARY DETAILS

Project ID	RAGS15-070-0133
Title	The Investigation on Arabic Word Pose Estimation Algorithm as Marker for Augmented Reality Application
Kulliyyah	Kulliyyah of Engineering
Duration	29

Researchers	
DR. Malik Arman Bin Morshidi (4570)	Principal
ASSOC. PROF. DR. Teddy Surya Gunawan (5588)	Co-Researcher

Fund Summary

Vote Code	Description	Initial Allocation (RM)	Current Allocation (RM)	Disburse (RM)	Committed (RM)	Balance (RM)
V11000	Research Assistant (RA)	30,000.00	25,200.00	25,200.00	0.00	0.00
V21000	Travelling Expenses And Subsistence	1,000.00	909.80	909.80	0.00	0.00
V29000	Professional Services & Other Services including Printing & Hospitality, Honorarium for subjects	6,000.00	10,032.20	10,032.20	0.00	0.00
V35000	Equipment	3,000.00	3,858.00	3,858.00	0.00	0.00
V36000	Miscellaneous Research Advancement	0.00	0.00	0.00	0.00	0.00
V37000	Travelling Research Advancement	0.00	0.00	0.00	0.00	0.00
Total		**40,000.00**	**40,000.00**	**40,000.00**	**0.00**	**0.00**

Fund Disbursed Detail

Disburse Date	Description	Supplier Name	Documentre	Total (RM)	Vote Code
17-04-2018	HONORARIUM - RESEARCH WORK	KAZI ISTIAQUE AHMED	EP18041553	900.00	B29404
22-03-2016	RESEARCH ADVANCEMENT_RAGS15-070-0133_REQUEST VOTE_V35000_RM1400_ANDROID PHONE_RM1600_IPHONE	MALIK ARMAN BIN MORSHIDI	EP16032309	3,000.00	A73107
20-07-2016	CLAIM_(ITEM ASSET, AMOUNT ASSET IS MORE THAT OUTSTANDING ADVANCEMENT)_RAGS15-070-0133_TO RECONCILE PV13016001097	MALIK ARMAN BIN MORSHIDI	EP16080660	309.00	A73107
12-04-2018	PUBLICATION FEE - IJEEI	MALIK ARMAN BIN MORSHIDI	EP18041177	490.45	B29120
26-10-2016	FINANCIAL CLAIM_CANON G2000 INK EFFICIENT PRINTER (PRINT,SCAN & COPY) 3 YRS WARRANTY OR 20,000 PAGES WHICHEVER COMES FIRST_DR MALIK ARMAN MORSHIDI_DEPT OF ELECTRICAL & COMP ENGINEERING, K.O.E	MALIK ARMAN BIN MORSHIDI	EP16120321	549.00	B27801

Outputs (For FRGS/RAGS/ERGS):

a) Human Capital Development

3-year project: At least 1 Phd or 2 Master student
2-year project: At least 1 Master student
Details of student

Student full name : Syarah Munirah Mohd Jailani
IC/ Passport No. : 910516-06-5474
Student ID : G1529806
Citizenship : Malaysia
Year of Graduation : 2019 (Expected)
Thesis Title : DEVELOPMENT OF ARABIC WORD POSE ESTIMATION ALGORITHM

b) Publication

(Note: A paper can only be reported once per grant)

Indexed Journal (At least 2 Papers)
(Note: Please use the following format to report the details of the paper;

1. Teddy Surya Gunawan, Muhammad Fahreza Alghifari, Malik Arman Morshidi, Mira Kartiwi, "A review on emotion recognition algorithms using speech analysis", *Indonesian Journal of Electrical Engineering and Informatics (IJEEI)* (2018), pp. 12-20.
2. Syarah Munirah Mohd Zailani, Malik Arman Morshidi, "Arabic Words Pose Estimation Using Infinitesimal Plane-Based Pose Estimation", accepted in *Symposium on Islamic Sciences and Technology 2018 (SISTECH'2018)*. In review, to be submitted in Advanced Science Letters.
3. Gunawan, Teddy Surya and Solihin, Nurul Shaieda and Morshidi, Malik Arman and Kartiwi, Mira (2017) "Development of efficient iris identification algorithm using wavelet packets for smartphone application", *Indonesian Journal of Electrical Engineering and Computer Science*, 8 (2). pp. 450-456.
4. Luqman Naim Mohd Esa, Malik Arman Morshidi, Syarah Munirah Mohd Zailani "Development of pose estimation algorithm for Quranic Arabic word", *TELKOMNIKA (Telecommunication Computing Electronics and Control)*, Vol. 16, No. 5, pp. 1633-1641.
5. Syarah Munirah Mohd Zailani, Malik Arman Morshidi, Luqman Naim Mohd Esa "Arabic words recognition technique for pattern matching using SIFT, SURF, and ORB", accepted in *2017 International Conference on Research and Innovation in Computer Engineering and Computer Sciences (RICCES 2017)*. In review, to be submitted in Journal of Advanced Manufacturing Technology.

c) Intellectual Property

d) Additional Outputs

Detail list of other outputs e.g.: non-indexed journal, conference proceeding/ book/ book chapters/ policy paper etc.

References:

Appendices