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Quantification Method for Video Motion Correction Performance in Mobile Image Sensor

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Abstract

The state-of-the art smartphones have a motion correction function such as an electric image stabilizer and record the video without shaking. As the motion is corrected in various ways according to the set maker, there is a difference in performance and it is difficult to distinguish clearly its performance.

This paper defines the Effective angle of View and Motion, for video motion correction performance evaluation. In the case of motion, we classified the motion volume, motion standard deviation, and motion frequency parameters. The performance of motion correction on the electronic device can be scored for each of parameters. In this way, the motion correction performance can be objectively modelled and evaluated.

Introduction

As for mobile image sensor mounted on a smartphone, the video is recorded as an unstable image sequences with the shaking. However, once EIS (electrical image stabilizer) function is correctly applied, the image will be stabilized and the shaking can be reduced. Since the shaking correction function is mounted on the mobile phone, the motion video information can be calculated and corrected. Depending on environment, the EIS methods are applied in several ways. For example, in low light brightness, there is little correction because it is difficult to distinguish movement due to noise of image sensor. Recently, motion synchronizer has been embedded on the sensor. By sing the Gyroscopic information synchronized to the sensor, the hand shaking can be exactly corrected in order to get the high-quality moving image. Video EIS creates high quality video. However, due to the limitation of the algorithm, effective angle of view is narrowed down to 70%. Usually, the effective angle and the EIS performance are trade-off. EIS performance should be secured by increasing the effective angle of view. And also, there is a difference in the performance of video motion correction for each set maker. As this is subjectively evaluated by each person, this paper introduces a numerical based quantitative evaluation method.

Proposed approach

For video motion correction, we define following two metrics for its performance evaluation, such as Effective angle of View and Motion.

Effective angle of View

Video EIS creates a high-quality video quality. However, due to the limitation of algorithm, effective angle of view is narrowed down to 70% as shown in Figure1. The effective angle and the EIS performance are trade-off. The important thing is that EIS performance should be secured by increasing the effective angle of view.

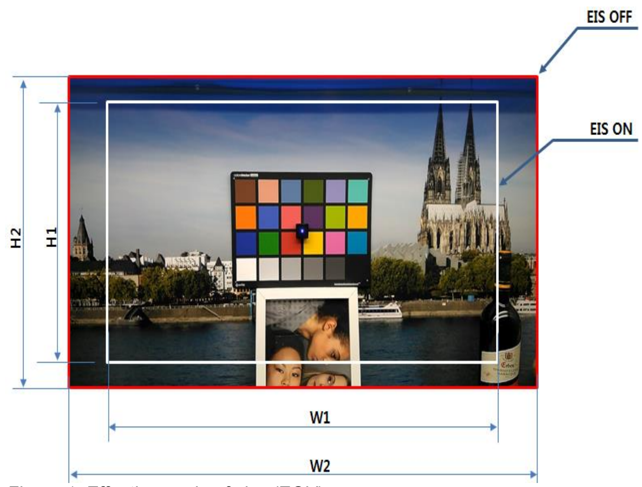


Figure 1. Effective angle of view(EOV)

$$EOV\ (\%) = (\frac{H1}{H2}) \times (\frac{W1}{W2}) \times 100$$

Motion

In the case of motion, motion volume (VOL), motion standard deviation (STDEV), and motion frequency (FREQ) are defined in our approach. The test chart has a gray background and a colored physical marker in Figure 2. Using the movement of the marker, the coordinates (x, y) are obtained. And using those coordinates (x, y), we can obtain volume (VOL), motion standard deviation (STDEV), and frequency (FREQ).

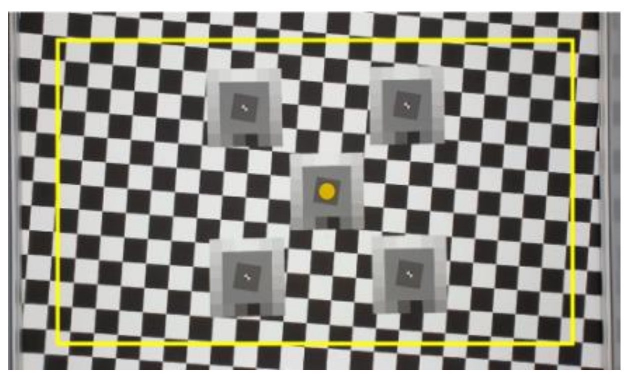


Figure 2. Chart for test

Motion Volume(VOL)

The difference between the coordinates of the previous frame marker and the current frame marker is called the motion volume.

Motion Standard Deviation(STDEV)

STDEV of the coordinates can be measured using the accumulated coordinates of the frame marker in the video. If the STDEV is close to zero, it means that there is little motion.

Motion Frequency(FREQ)

When the shaker applies repetitive shaking(Hz) for a certain period of time, a video is recorded on the phone, then the coordinates (x, y) of the frame have a constant motion. As the performance of the EIS correction algorithm decreases, it has a larger value than the shaker setting (Hz). As a result, the accumulated motion volume increases.

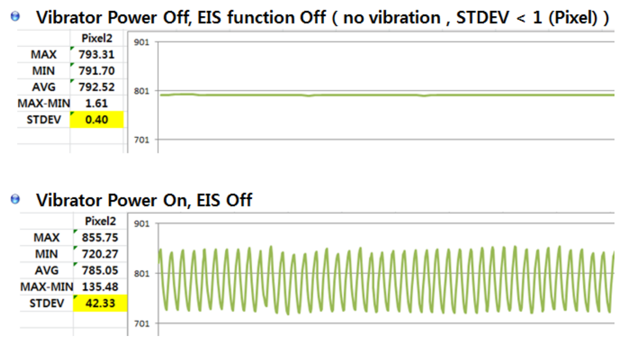


Figure 3. Definition of no shaking

How to Evaluation Method

The Table 1 shows a list of experimented cameras.

Table 1. Examples of Evaluated cameras

	Company A		Company B	Company C
Type	Mobile		Action Camera	Action Camera
Motion Correction	EIS	EIS	EIS	Gimbal
Optical Spec	1/25″, F1.5/2.4 (Wide)	1/3″, F2.2 (Ultra Wide)	1/2.3″, F2.8	1/2.3″, F2.0
Sensor	1.4um, 12Mp	1.0um, 16Mp	1.55um, 12Mp	1.55um, 12Mp
FOV	79.5˚	122˚	122.6˚	80˚

Verification Environment Modeling

Depending on the brightness, color temperature, and degree of shaking, the recording condition of the video has been modeled. The Table 2 shows the setting values of the various conditions selected for modeling.

Table 2. Motion Modeling

※ Recording Distance: 100cm

No	Illumination (lux)	Color Temperature (K)	Modeling Motion Setting at Vibrator	Modeling
1	1000	5000	Walking motion	Walking on the road in the afternoon

Initialization

The initialization of the evaluation environment removes the surrounding variables which hinder when evaluating the EIS performance. It should be confirmed that there is no shaking by checking the standard conditions without shaking in the test environment that can cause forced shaking in Figure 3.

Recording the Video

After in-activation of the shaking correction function, a reference value of a plurality of parameters can be obtained, an activation of the shaking correction means function, and a measurement value for the plurality of parameters can be obtained in an image photographed by the electronic device while a forced shaking occurs. The test chart has a gray background and a colored physical marker. The Figure 4 shows the evaluation environment for recording video.

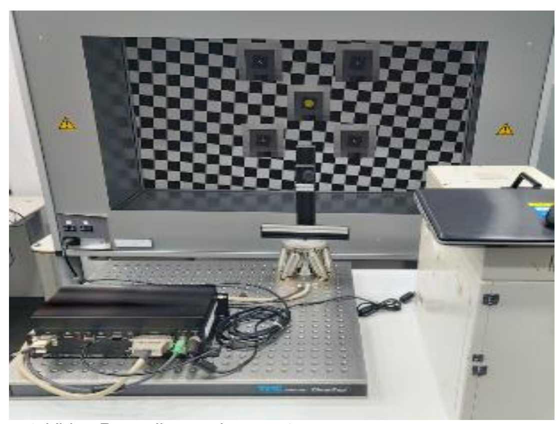


Figure 4. Video Recording environment

Verification, Scoring and Result

Effective angle of View of Set Maker

EOV is different depending on the company shown in Figure 5. The results of the scoring are shown in Figure 6.

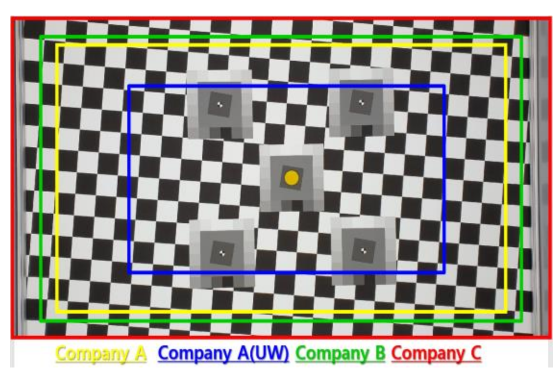
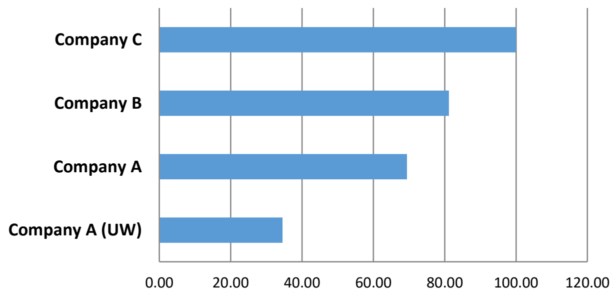


Figure 5. Effective angle of view (EOV) of Handset



	Company A (UW)	Company A	Company B	Company C
EOV	34.51	69.45	81.16	100.00

Figure 6. Scoring of EOV

Motion of Set Maker

Coordinates (x, y) are used as auxiliary indicators by creating graphs in order to check trends in Figure 7. Because the algorithm and method for motion correction are different, the trace of the maker appears in different way.

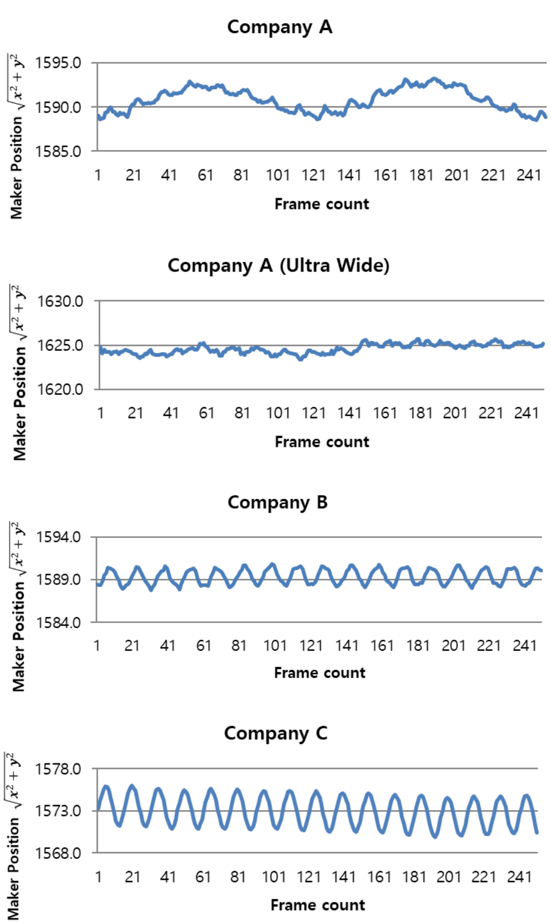


Fig. 7. Motion graph using maker position

Scoring

The reference motion value can be obtained for the case of shaker turn on/off or EIS turn on/off. The best score and worst scores are calculated as 100, 0 points, respectively. Therefore, the motion can be measured by shaker on / EIS on, and the score can be calculated in the form of matching the measurements shown in Table 3.

Table 3. Score calculation

		Shaker	EIS	Score (%)	Remarks
Motion	Volume (VOL)	Off	Off	100	
		On	Off	0	
		On	On	Measure	Calculates the score by matching the result values
	Standard Deviation (STDEV)	Off	Off	100	
		On	Off	0	
		On	On	Measure	Calculates the score by matching the result values
	Frequency (FREQ)	On	Off	100	
		-	-	0	Zero points based on (N) times the result values.
		On	On	Measure	Calculates the score by matching the result values

Result

Finally, we can get the score using the weight, motion and EOV shown in Table 4. For each item, the predominant items are mixed. But in terms of overall performance, it can be seen that Company B is the best. In case of Company A and Company A (Ultra Wide), Frequency item accuracy score is very low. This implies that the motion correction is irregular. In case of Company A (Ultra Wide), EOV item's score is very low, so it can be seen that field of view loss is very high. Performance weight can be applied considering the importance for their own preference.

Table 4. Experimental results with score

Set	Vibrator Setting (Hz)	Lux	STDEV (a%)	Volume (AVG) (b%)	Frequency (Hz) (c%)	EOV (%) (d%)	Total Score
Company A	2	1000	81.84	89.04	17.70	69.40	75.20
Company A (UW)	2	1000	84.13	91.70	21.60	34.50	76.05
Company B	2	1000	89.11	83.76	90.20	81.10	86.20
Company C	2	1000	77.33	71.75	100.00	100.00	79.07

$$Score(x,y) = a \cdot STDEV(x,y) + b \cdot VOL(x,y) + c \cdot FREQ(x,y) + d \cdot EOV$$

Conclusion

The motion correction performance can be modeled. In resultant, the reference value and measurement value obtained for each of parameters, accordingly.

It is very difficult to know the exact performance by subjective evaluating of the video motion correction. In order to solve this problem, this paper proposed novel numerical based quantitative evaluation method.

In addition, each of the parameters can be weighted. So, the trade-off between the size difference (EOV) and the performance of compensating for the shaking can be effectively considered. The weights assigned to each of the parameters may be variously modified according to the situation. Therefore, the motion correction performance of set can be objectively evaluated. The proposed methodology was verified with diverse camera applications.

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