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Performance Analysis of Video Magnification Methods

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Abstract*- Video is a huge source of information and the only way to extract that information is video processing. Depending upon the information to be retrieved or analyzed, the video processing techniques are applied. Some of the information consists of imperceptibly small motion, color changes, or sound changes. To estimate the small motions, which are not visible to naked eyes, various video magnification techniques are used. In this paper, various video magnification techniques- Eulerian video magnification, Phase-based video magnification with both Laplacian and Gaussian pyramid are implemented and their comparative performance analysis is presented. The various performance metrics used are PSNR, amplification factor, execution time, intensity of color and motion magnification. The effect of changing the level of pyramid and amplification factor on the performance of particular method is also analyzed. With increase in the level of pyramid quality of magnification reduced, while for higher amplification factor (>200) output exploited drastically. Results reveal that the Eulerian video magnification method is fast and simple but supports small amplification factors while the phase-based method is very slow and complex but supports the large amplification factors. To get better performance of the video magnification method, it is required to develop a new method using hybrid approach and its scope can be further extended in biomedical field to measure the biological parameters.

***Keywords*- Eulerian video magnification, Phase-based video motion magnification, PSNR, Color, Motion**

I. INTRODUCTION

Digital video is the reel of the number of digital image frames aligned back to back and runs with a certain speed of frame per second for the specified time interval. Every digital image frame video consists of digital 1's and 0's, by converting analog values of Luminance, Brightness, and Chrominance concerning bit depth and hence it contains lots of imperceptible information within them. Video motion magnification techniques allow humans to explore such imperceptible information visibly. This imperceptible information consists of color variation, vibrations, and many more to discover [15][16]. Eulerian and Phase-Based video magnification methods are used to decompose and magnify such information from the video. Proposed work is to understand both Eulerian and phase-based video magnification methods by implementing them with controlled inputs and analyzing their performance based on standard parameters. The quality of the video can be measured with formal metrics PSNR or through subjective video quality assessment using expert observation. So PSNR, Execution time, Level of the pyramid, Amplification Factor with subjective user observation of intensity of color and motion magnification in output video are the performance parameters used for analysis.

Further paper is organized in various sections. In section II, related work regarding video magnification methods is presented, then understanding hardware and software video magnification methodologies in section III. Strategies for selection of performance parameters are discussed in section IV. While the implementation and results are discussed in section V, further analysis based on results is concluded in section VI.

II. RELATED WORK

Numerous researchers worked in the field of video magnification to develop an efficient, effective, and robust method. Here is the brief of work done by researchers.

Ali Al-Naji and Javaan Chahi [1] presented a contactless technique of video magnification with a fuzzy interference system and output has increased efficiency. At CSAIL Hao-Yu Wu *et. al.* [2] worked in the contactless field to measure biomedical parameters using the Eulerian video magnification method and successfully magnified imperceptible color changes on the human body. Similarly, at CSAIL Neal Wadhwa *et al.* [3] also worked in the contactless field to measure biomedical signals but using Phase-based video magnification. Authors researched for motion attenuated color changes in input videos. M. P. Popek *et al.* [4] implemented VMM techniques to observe frequency response which corrupts to a greater extent. Yichao Zhang *et al.* [5] proposed Video Acceleration Magnification to to cope with large motions while still magnifying small changes. Authors revealed two observations: large motions are linear on the temporal scale of the small changes and small changes deviate from this linearity.

Le Liu *et al.* [6] used the video magnification method to manipulate small movements in the video based on spatial-temporal filtering. On the other hand, Philipp Flotho *et al.* [7] worked on Lagrangian Motion Magnification to show that under ideal conditions in the context of psychophysiological experiments, using dense optical flow estimation, magnification occurs. Haotian Yu *et al.* [8] implemented Region-Based Euler video amplification. The method performs more efficiently with higher SNR. Also, Christopher J. Tralie and Matthew Berger [9] introduced a tracking free Eulerian approach for synthesizing a single cycle of motion. They worked on each frame as a point in high-dimensional Euclidean space to analyze the sliding window embedding formed by this sequence of points, yields samples along a topological loop regardless of the type of periodic motion. Gamal Fahmy *et al* [10] used complex wavelet frequency to reveal micro motions and hence named micro-motion magnification.

From the survey, it is observed that all methods are revealing the imperceptible variation for video but accuracy, noise sensitivity, quality, corruption of frames, execution time are the parameters that differentiating these methods. And hence for any methods, there should not be compromised for quality, speed, and robustness. That's why further work done for analyzing performance of some of the mostly used video magnification methods based on standard performance parameters to further develop a hybrid approach.

III. VIDEO MAGNIFICATION METHODS

The objective of the paper is to implement and analyze the video magnification methods based on performance parameters. Video magnification can be performed by different methods including hardware as well as software methods as shown in Fig. 1.

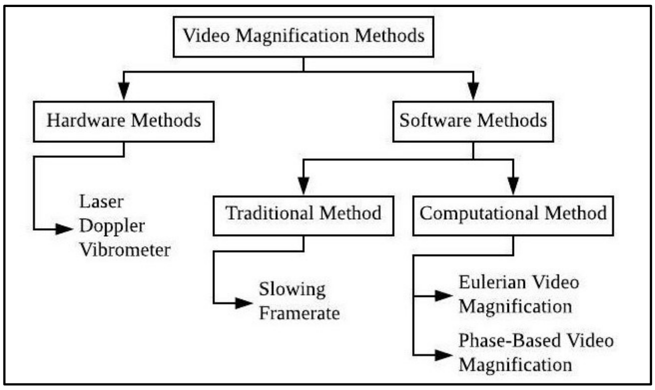

Fig. 1. Clasification of Video Magnification Methods

A. Hardware method

1) Laser Doppler Vibrometer: This is a hardware based non-contact video magnification method, specifically magnifies motion in the video using Laser and Doppler shift. The hardware setup includes the laser beam which is directed on the surface and the reflected beam is received by detector [12]. As shown in Fig.2. Laser beam of high frequency ($>10^{14}$ Hz) f_o splits in to reference beam f_o and test beam. The test beam passes through the Bragg cell to add frequency shift $f_o + f_b$. This frequency shift beam collides on the target and gets reflected. The reflected beam has a doppler shift due to target velocity as $v(t)$. Doppler shift can be given by

$$f_o = 2 * v(t) * \frac{\cos(\alpha)}{\lambda} \quad (1)$$

where α is the angle between the laser beam and the direction of object velocity, λ is the wavelength of laser light. The reflected light is detected by photodetector having a frequency as $f_o + f_b + f_d$. This frequency gets combined with reference frequency at the detector. The initial laser frequency is very high and compared with detected one to have a Doppler shift which is used for magnification of surface motions.

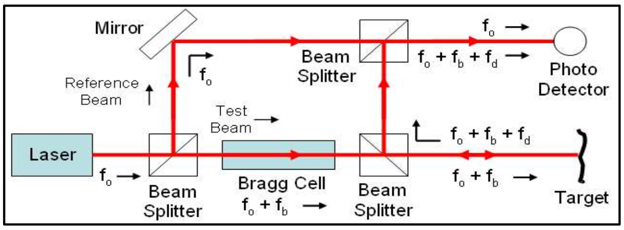

Fig. 2. Laser Doppler Vibrometer working ray diagram

Source: Laderaranch, Basic schematic of a laser Doppler vibrometer (September18, 2008), Retrieved June26, 2020 from https://en.wikipedia.org/wiki/Laser_Doppler_vibrometer#/media/File:LDV_Schematic.png

Output generated by photo detector is frequency modulated (FM) signal, consisting Bragg cell frequency $f_o + f_b$ as the carrier frequency, and Doppler shift as modulation frequency. This signal can be demodulated to have modulating signal which was imperceptible before and now can be fused in original video of target surface.

B. Software methods

1) Traditional Method:

a) Slowing framerate: In this traditional method any video processing software able to handle individual frames is required. As shown in the Fig. 3, Camera strip denotes the input video with 20 frames where the Projector strip denotes the projected slow-motion video. The technique reduces the alternate frames and exactly halves the framerate. Therefore it slows down the video for human eyes. Hence framerate of input recorded video should be double of the framerate required in the output. Though this technique slows the video but leads to the major loss of data and results in loss of information [17].

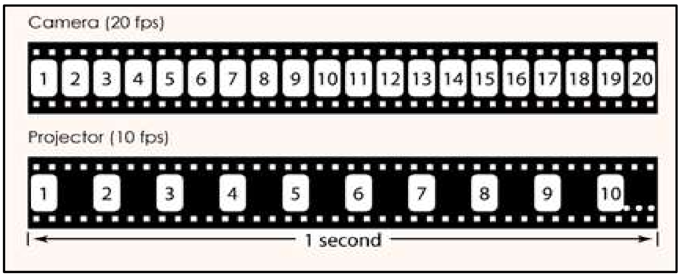

Fig. 3. Framerate reducing technique

Source: MGA73bot2, Overcranking Timeline (November12, 2005), Retrieved June26, 2020 from https://en.wikipedia.org/wiki/Slow_motion#/media/File:OvercrankingTimeline.png

2) Computational Method: From big family under this division, Eulerian video magnification (EVM) and Phase-Based video magnification (PVM) are selected for performance analysis as they are widely evolved and mostly used methods. Both the methods work on the gerneralised computational algorithm and this generalized algorithm is shown in Fig. 4.

Data Acquisition and separation of frames: At first step of data acquisition, 10-sec video of target is captured with proper light conditions as the input video. Target in the video should be with minimum movements and should cover most of the screen in order to collect more precise and vivid data for processing. A camera with good sensors will always be great, but the normal smartphone camera can also be used. The video should be stable with the camera on a tripod or with steady hands. Any kind of video compressing codec should be avoided which will reduce data quality and will affect results. But to enhance the accuracy of video data HEVC and N-HEVC codec can be prefered [18] [19]. Camera frame rate should satisfy Nyquist criterion which is $f_s = 2 * f$ where f is the highest frequency which is to be extracted and magnified from video and f_s is the frame rate. Here for a human as a target, f will be between 1Hz (60BPM) to max 3Hz (180BPM) according to [1]. Second step works on seperation of individual frames from video and preparing them for further processing. After seperation, each frame is prepared with respect to their spatial properties like pixel size, phase and amplitude and hence this step is refered as spatial processing as in Fig. 4.

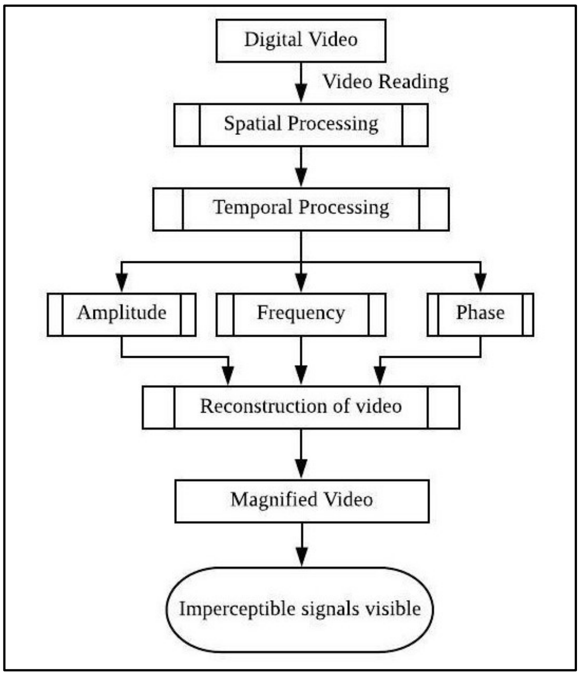

Fig. 4. General video magnification method block diagram

Spatial processing: It is the step where EVM and PVM are differentiated from each other. At this step Gaussian pyramid is generated in EVM where complex steerable pyramid in PVM. Its generation is discussed in detail in further sections of paper. Pyramids are generated to improve the signal-to-noise ratio (SNR) so that signal should be more over noise for better results.

Temporal processing: In this next step, pyramids are passed through the bandpass frequency filter which allows only the imperceptible signal that needs to be magnified from video and then amplified. For both the methods process for selection of bandpass is same. For coefficients of the bandpass filter, first window frequencies should be selected as in Fig. 5. For imperceptible signal as pulse rate of human [2], lower cut off window frequency (f_l) is 1Hz (60BPM) and higher cut off window frequency (f_h) is 3Hz (180BPM). Because of very narrow band, sharp edge bandpass filter should be selected. For coefficients f_l and f_h are converted rad/sample as follows

$$f\left[\frac{rad}{samples}\right] = f\left[\frac{cycles}{sec}\right] * \left(\frac{sec}{cycles}\right) * \left(\frac{rad}{cycles}\right) \quad (1)$$

$$f\left[\frac{rad}{samples}\right] = f\left[\frac{cycles}{sec}\right] * \left(\frac{2\pi}{fs}\right) \quad (2)$$

Where f[cycles/sec] is BPM value and f_s is sample rate of video in Hertz [15].

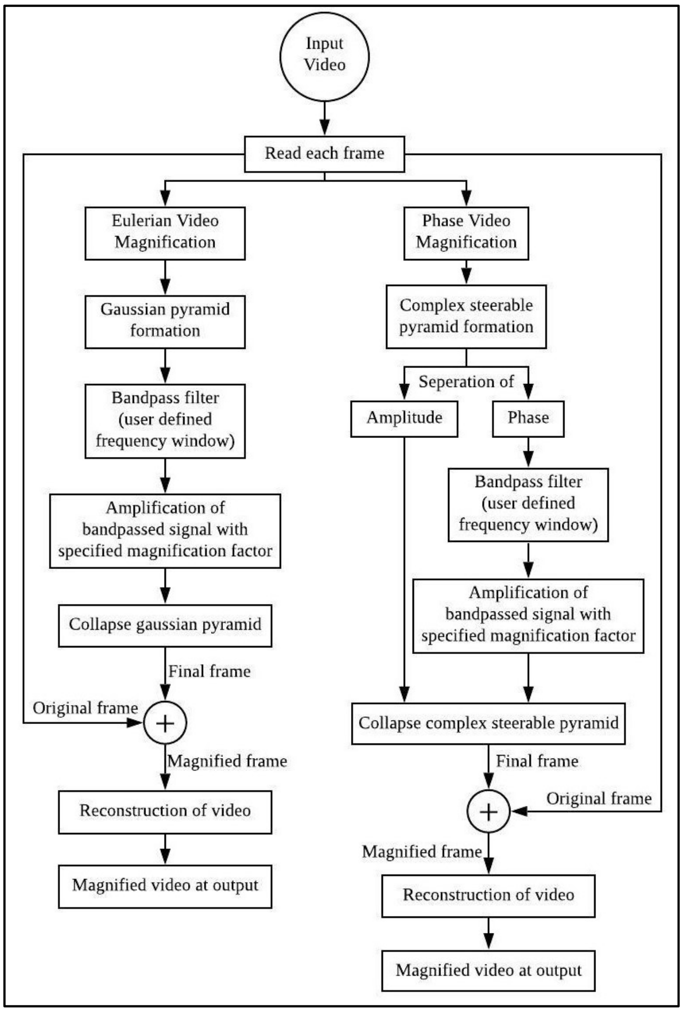

Fig. 5. EVM and PVM algorithm

For EVM whole gaussian pyramid is passed through filter while in PVM only phase of complex steerable pyramid is allowed. As the frequency of interest for the required application is selected, further step for both methods is to amplify that signal. Band-passed signal amplified with the multiplication factor ‘α’. Lower spatial frequencies can be emphasized by α. α can be selected after number of test experiments. Since α has some bounds because beyond some limit can cause violation of extracted signal leading to distortion in result [11]. It produces more noise and spoils exaggeration of signals.

Reconstruction of Video: After temporal processing, in reconstruction process final magnified signal is added to original frames and rendered with timeline to produce magnified video, which is able to show magnified imperceptible signals very clearly as shown in Fig. 4.

Further both EVM and PVM are explained with detail algorithm in Fig. 5.

a) Eulerian Video Magnification (EVM): From algorithm shown in Fig.5, gaussian pyramid is calculated for each frame. Let frame $I(x,y)$ is input frame and $G(x,y)$ is gaussian pyramid frame then

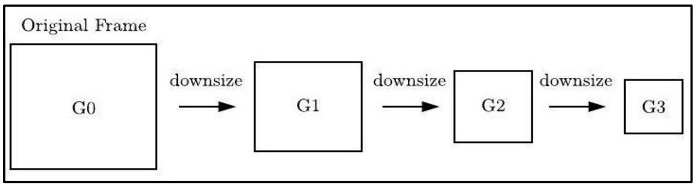

Fig. 6. Gaussian pyramid algorithm

$$G(x,y)\,\Sigma_m \Sigma_n\, w(m,n)Gj - 1(2i+m, 2j+n) \quad (3)$$

Where, $w(m,n)$ is the kernel of specific height and width. This kernel convolves the input frame to produce a next reduced image of the previous input image. Such pixel manipulations are combined under spatial processing. At each step image gets halved w.r.t previous height and width as shown in Fig 6.
Method of temporal processing offers a broad scope for filtering required signals of each frame concerning the perfect video timeline. To understand the relation between temporal processing and motion magnification. Let's consider $I(x,t)$ as image intensity at position x and time t. After the motion of $\delta(t)$, intensity becomes

$$I(x,t) = f\big(x + \delta(t)\big) \quad (4)$$

and for amplification factor α intensity becomes

$$I(x,t) = f\big(x + (1+\alpha)\delta(t)\big) \quad (5)$$

Using 1st order Taylor series expansion, the approximated equation becomes

$$I(x,t) \approx f(x) + \delta(t)\,\frac{\partial f(x)}{\partial x} \quad (6)$$

Now suppose after applying bandpass filter as in algorithm stated in Fig. 5, bandpass signal is given by

$$B(x,t) = \delta(t)\,\frac{\partial f(x)}{\partial x} \quad (7)$$

So, in next steps from Fig. 5, for amplification, multiply $B(x,t)$ by α and adding it to the original signal after collapsing back all pyramid frames for reconstruction gives

$$\tilde{I}(x,t) = I(x,t) + B(x,t) \quad (8)$$

Now combining equations 6, 7, and 8 we have

$$\tilde{I}(x,t) \approx f(x) + (1+\alpha)\delta(t)\,\frac{\partial f(x)}{\partial x} \quad (9)$$

And for larger frames and timeline, the simple equation becomes

$$\tilde{I}(x,t) \approx f(x) + (1+\alpha)\delta(t) \quad (10)$$

That's how $\tilde{I}(x,t)$ contains original video with exaggerated visible magnified motion. As supposed above, along with imperceptibly small motion change, $\delta(t)$ can any of color signal, vibration sound signal and many more yet to discover [1].

b) Phase-Based video magnification (PVM): The noise in the video is majorly due to the motion of the camera or the target in the video. The phase-based method first reduces these motions from video i.e. most of the noise gets reduced [2].

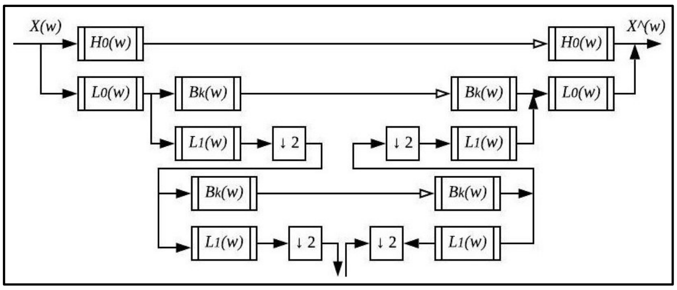

Fig. 7. Complex steerable pyramid algorithm

Acoording to the algorithm described in Fig. 5, for complex steerable pyramid, 2D Discrete Fourier Transform (DFT) is computed over all frames in the video. Subsequent spatial filters with different sizes and orientations are applied $(L_0(w), B_k(w))$ as in Fig. 6. This produces a linear multi-scale and the multi-orientation image decomposition called the complex steerable pyramid. Each level of the pyramid is an array of complex numbers, and their phase and amplitude are computed, element by element. From Fig. 7 algorithm, H, L, and B represent high, low and bandpass filters, respectively. $H_0(w)$ is a non-oriented high pass filter and on the other hand, $L_0(w)$ is the narrow band low pass filter and $B_k(w)$ refers to the bandpass filters (k = 0,1,...K) and K is the total number of filters. For avoiding the effect of aliasing, the bandpass components should not be downsampled. If $X(w)$ is considered as the original image then in the Fourier domain the resultant reconstructed image is as follows:

$$\hat{X}(w) = [|H_0(w)|^2 + |L_0(w)|^2 + |L_1(w)|^2 + \Sigma_{k=1}^{n}|B_K(w)|^2]X(w) + a.t \quad (11)$$

Where a.t are used for aliasing terms

$$L_1(w) = 0 \text{ for } |w| > \frac{\pi}{2} \quad (12)$$

In the desire of avoiding the amplitude distortion, a system transfer function is constrained as

$$|H_0(w)|^2 + |L_0(w)|^2 + |L_1(w)|^2 + \Sigma_{k=1}^{n}|B_K(w)|^2 = 1 \quad (13)$$

And for the system cascading

$$|L_1\left(\frac{w}{2}\right)|^2 = |L_1\left(\frac{w}{2}\right)|^2 * [|L_1(w)|^2 + \Sigma_{k=1}^{n}|B_K(w)|^2 \quad (14)$$

And the angular constraint on the bandpass filter is $B_k(w)$ determined by the condition of steerability and seen as

$$B_k(w) = B(w) * [-j(\cos\theta - \theta_k)]^n \quad (15)$$

Where $\theta = \arg(\omega)$

$$\theta_k = \frac{k\pi}{(n+1)} \text{ for } B(w) = \sqrt{(\Sigma_{k=0}^{n} |B_k(w)|)} \quad (16)$$

Here n=3 is considered. Boxes containing "2 ↓" and "2 ↑" correspond to down sampling and up sampling by a factor of 2, respectively. Motion attenuation is the only effect of the steerable pyramid. As the steerable pyramid has been built, in next step the amplitude and the phase of each spatial scale separated. Only phase is passed through the temporal bandpass filter to filter out large motions but to pass required signals as in Fig. 5. These signals are then amplified with amplification factor. Temporally filtered phase pyramid is added to amplitude again and then collapsed to get the final frame as in Fig. 5. After reconstruction of output video large motion gets attenuated with amplification of imperceptible colors on the target. In this way because of spatial filters of different orientation, phase is separated in complex steerable pyramid which helps for motion attenuation over gaussian pyramid.

IV. PERFORMANCE PARAMETERS

As the normal video consists of various types of noise and unwanted motion. Hence while analyzing color video magnification methods, it is important to analyze video quality after magnification. Also, the efficiency and intensity of magnification.

A. PSNR (Peak Signal to Noise Ratio)

The increasing of the pixel intensity due to magnification is normally associated with a decrease in the quality of the video. To check the quality of the processed video, PSNR which is Peak signal to noise ratio is calculated. It is used to decide image quality after temporal variations or compression in the image [13]. It is calculated between the original frame and the magnified frame of the video.

$$PSNR = 10 \times \frac{log_{10}(255^2)}{MSE(Io,Im)} \quad (17)$$

Where MSE is mean square error of Io and Im.

$$MSE = \frac{1}{MN} \Sigma_{i=0}^{M-1} \Sigma_{j=0}^{N-1} (I_o(i,j) - I_m(i,j))^2 \quad (18)$$

Io is the original image i.e. frame of the input video and Im is magnified image i.e. frame of magnified video at the output. PSNR in the lossy image and video compression should be between 30 and 50 dB [20], provided the bit depth is 8 bits, where higher is better.

B. Execution Time

Along with achieving the high PSNR, it is equally important to develop an algorithm which processes the information fast. Execution time is another parameter to measure performance. In this work, it is recorded for every case to reveal which method is fast enough to magnify the video. It gives the trend of execution speed over some selection parameters for the method. Fast algorithms are required while developing real-time applications where the system deals with huge data.

C. Color Magnification Intensity

In video magnification methods, colors related to the selected frequency range are got magnified in the video with human as the target [2]. Color magnification Intensity is a qualitative parameter and it is used to observe the variation of color with change in pyramid level in both the methods EVM and PVM.

D. Motion Magnification Intensity

The magnification of color sometimes leads to magnification of small motion [3]. This can majorly destruct the output and make it unrecognizable. Hence to know its effectiveness Motion Magnification Intensity is used as qualitative parameter. It is also used the change in intensity with change in pyramid level in both the methods EVM and PVM.

Above both of the intensity parameters are noted by bare eye observation of the authors and accordingly calibrated as extremely destructive, extreme, high, medium, low, and least for computational interpretation.

V. RESULTS AND DISCUSSION

Out of various methods of video magnification, computational methods- Eulerian and phase-based video magnification methods are implemented and analyzed. As a first step, database of videos is prepared with wide range of inputs including five types of cases - video of fair shade person and a person with dark skin tone with frame size 528×592 (30fps), a face having on side illuminated most than other, side view of the face, and one month born sleeping baby with frame size 640×352 (30fps). All videos are selected in such a way that every real-time situation gets covered. These are recorded on a rear camera of Motorola G4 plus and Samsung galaxy7 with 1080p 30fps. Some are directly taken from the database available over the internet each of 10 seconds interval [2][3]. These videos are processed with MATLAB R2019a on a laptop with specifications of 4GB RAM, Intel Core i5 7^{th} Gen @ 2.50GHz processor, and Windows 10 operating system.

To analyze the performance of these methods, two quantitative metrics- PSNR & Execution time and two qualitative metrics- Color magnification intensity & Motion magnification intensity are considered. Table 1 depicts performance results for both the methods.

As mentioned in section III, every method exhibits magnification of colors associated with the selected temporal frequency range. It can also be observed from the table 1 that by increasing the levels of pyramid in both Eulerian and Phase-based method, the PSNR is increased but on the other hand it requires less time to execute the algorithm. Similarly color magnification intensity is decreased but motion magnification intensity remains same. The same is plotted in the fig 7 and 8, which clears that with an increase in the level of the pyramid, PSNR increases gradually while intensity of color magnification lowers for every case.

Specifically, in case of Eulerian Video magnification method, when the level of the Gaussian pyramid is set to 4, the

Methods	Performance metrics				
	Pyrami-d levels	PSNR (dB)	Execution time (sec)	Color magnific-ation intensity	Motion magnific-ation intensity
Case 1- Face1 fair shade					
Eulerian Video Magnification	4	36.84	38.13	High	Low
	5	38.87	37.02	Medium	Low
	6	41.05	33.74	Low	Low
Phase Video Magnification	4	40.10	545.31	High	Least
	5	41.07	536.35	Medium	Least
	6	42.15	526.88	Low	Least
Case 2- Face2 dark shade					
Eulerian Video Magnification	4	34.17	42.31	High	Low
	5	37.43	43.57	Medium	Low
	6	41.03	43.37	Low	Low
Phase Video Magnification	4	40.97	687.35	Low	Least
	5	42.51	685.98	Low	Least
	6	44.36	685.66	Low	Least
Case 3- Face3 one side light					
Eulerian Video Magnification	4	31.19	26.88	High	High
	5	35.83	26.99	Medium	Low
	6	40.64	25.81	Low	Low
Phase Video Magnification	4	36.79	337.03	Medium	Least
	5	38.96	331.24	Low	Least
	6	42.31	329.93	Least	Least
Case 4- Face4 sideview					
Eulerian Video Magnification	4	23.30	22.63	High	High
	5	25.38	22.40	Medium	Low
	6	27.73	23.50	Low	Low
Phase Video Magnification	4	25.60	281.62	High	Least
	5	26.66	280.62	Medium	Least
	6	28.01	281.26	Low	Least
Case 5- Sleeping baby					
Eulerian Video Magnification	4	39.39	70.85	High	Medium
	5	42.26	71.24	Medium	Low
	6	44.22	70.47	Low	Low
Phase Video Magnification	4	41.84	1228.29	Medium	Least
	5	43.13	985.74	Low	Least
	6	44.37	910.62	Least	Least

intensity of motion magnification is low for case1 and case2, but high for case3 and case4, while medium for case5. But when its levels are 5 and 6, motion magnification is low in all cases. Considering execution time, it remains the same, except for case1 where it decreases with an increase in the level of Gaussian pyramid as plotted in Fig. 8.

In the case of Phase video magnification with an increase in the level of the steerable pyramid, PSNR increases with very small increments for every case as plotted in Fig. 10. According to analysis in Table 1, with an increase in the level of the steerable pyramid, the intensity of color magnification lowers for every case, such that for case3 and 6 it becomes least can be seen in Fig. 10, while the intensity of motion magnification is interestingly constant for all the cases. Execution time remains almost same for all the cases concerning increase in the level of the steerable pyramid. For case5, execution time shows major decrease as plotted in Fig. 10

TABLE I. ANALYSIS BASED ON PERFORMANCE METRICS

From the results obtained, it is observed that case1 (Fair shade face) and case5 (Sleeping baby) are cases for which best results are obtained. Case1 consists of a video of an adult person with fair shade and front view and case5 consists of a video of a sleeping baby with a distant side view. Another analysis is presented in table 2 by considering these two cases only. It focuses on effect of variation in amplification factor to performance metrics. For both cases, the level of pyramid is kept 4 as the results are quite magnified and stable at this level and amplification factor is varied. For both cases, the amplification factor is varied gradually from 25 to 400 and variation in performance metrics is tabulated in table 2 as well as plotted in Fig 11 for PSNR variations. It is clear that with increase in amplification factor PSNR decreases for both methods i.e. degrades the quality of magnified video. In other words, quality of magnified output video is comparatively poor than input video for higher amplification factors.

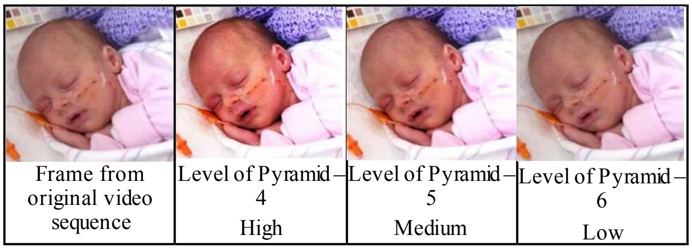

Fig. 8. Intensity of color magnification for case 5 using PVM

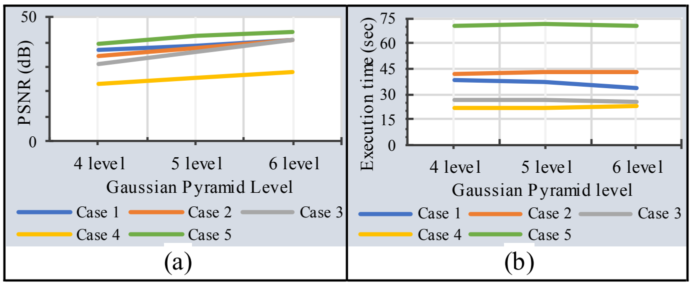

Fig. 9. Analysis of (a) PSNR and (b) Execution time with variation of Gaussian pyramid using EVM

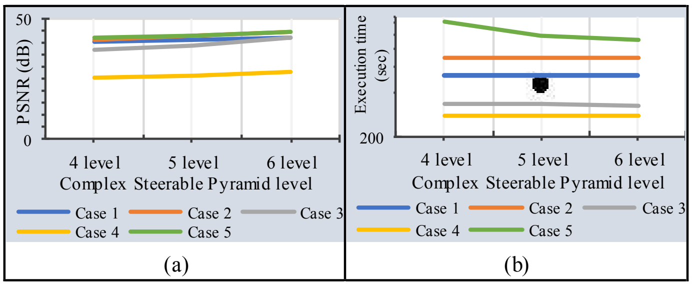

Fig. 10. Analysis of (a) PSNR and (b) Execution time with variation Complex Steerable pyramid using PVM

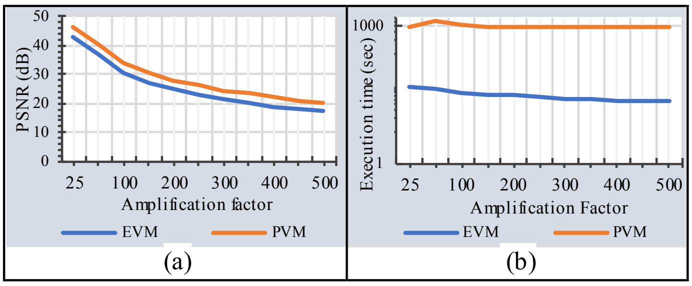

Fig. 11. Analysis of (a) PSNR and (b) Execution time with variation of Amplification factor using both EVM and PVM

It can be observed from Table 2, that Color magnification intensity becomes extremely destructive for higher amplification factors for both case1 and case5. While motion magnification intensity is extremely destructive in the case of Eulerian but its constantly least in case of Phase video magnification, as amplification factor goes higher. Considering case5, the variation of execution time with the amplification factor for both methods is plotted in Fig. 11. The line graph clearly shows that an increase in amplification factor doesn't affect execution factor majorly, but it reduces execution time by a few seconds in both cases for both methods.

According to results, towards an approach to the objective, the factors that effects on results are discussed below:

Pyramid level- For the Eulerian video magnification method, an increase in the level of the pyramid leads to an increase in PSNR but the intensity of magnified color in output video become weak and intensity of motion magnification in output video constantly remains low. The same trend is seen for the Phase video magnification method, only with the least intensity of motion magnification.

Amplification factor- For best case1 and case5, with an increase in amplification factor (level of pyramid fixed to 4), PSNR decreases for both video magnification methods. For Eulerian video magnification, output frames exploit due to extreme color and motion magnification. While in case of phase video magnification, output become unrecognizable because of extreme color magnification even motion magnification is least. And hence collectively the quality of output video degrades for higher amplification factors (> 200).

Execution Time- From table 1., it is clear that the PVM takes nearly 10-20 times more time than the Eulerian method. In the PVM complex steerable pyramid formation with separation of amplitude form phase contributes to time increment even for standard specification hardware. Level of pyramid doesn't affect that much cause with an increase in level processing steps increased but execution time deflected by nearly 2 to 4 seconds for both the video magnification methods.

For a higher-level pyramid, the intensity of color magnification becomes less visible to human eyes. So, it is better to restrict the pyramid level to 4 or 5 for better results until PSNR doesn't drop below 30dB. The phase-based method takes so much time than the Eulerian method. Execution time also depends on hardware configurations. For 16GB RAM laptop Phase-based method may work with less time but again it crosses the line of cost, causes with greater specifications cost increases gradually.

VI. CONCLUSION

TABLE II. OBSERVATIONS OF VARIATIONS IN AMPICATION FACTORS

Case 1- Face1 fair shade								
	Eulerian Video Magnification				**Phase Video Magnification**			
Amplification factor	**PSNR (dB)**	**Execution time (sec)**	**Color magnification intensity**	**Motion magnification intensity**	**PSNR (dB)**	**Execution time (sec)**	**Color magnification intensity**	**Motion magnification intensity**
25	42.86	34.24	Least	Least	46.11	600.59	Least	Least
50	36.84	38.13	High	Low	40.10	545.31	High	Least
100	30.83	33.62	High	High	34.09	572.06	High	Least
150	27.32	34.88	Extreme	Extreme	30.58	560.58	Extreme	Least
200	24.84	33.26	Extreme	Extreme	28.09	555.14	Extreme	Least
250	22.94	33.77	Extremely destructive	Extremely destructive	26.17	554.69	Extreme	Least
300	21.39	33.14	Extremely destructive	Extremely destructive	24.59	551.59	Extremely destructive	Least
350	20.11	33.81	Extremely destructive	Extremely destructive	23.27	554.60	Extremely destructive	Least
400	19.01	33.07	Extremely destructive	Extremely destructive	22.12	554.06	Extremely destructive	Least
Case 5- Sleeping baby								
	Eulerian Video Magnification				**Phase Video Magnification**			
Amplification factor	**PSNR (dB)**	**Execution time (sec)**	**Color magnification intensity**	**Motion magnification intensity**	**PSNR (dB)**	**Execution time (sec)**	**Color magnification intensity**	**Motion magnification intensity**
25	45.38	76.25	Least	Least	47.83	967.85	Least	Least
50	39.39	73.88	High	Medium	41.84	1228.29	Medium	Least
100	33.42	76.92	High	High	35.84	1029.30	High	Least
150	29.95	74.18	Extreme	Extreme	32.35	968.94	Extreme	Least
200	27.49	73.67	Extreme	Extreme	29.87	957.04	Extreme	Least
250	25.61	73.77	Extremely destructive	Extremely destructive	27.96	951.17	Extreme	Least
300	24.08	74.89	Extremely destructive	Extremely destructive	26.41	955.59	Extremely destructive	Least
350	22.82	74.62	Extremely destructive	Extremely destructive	25.11	966.99	Extremely destructive	Least
400	21.75	75	Extremely destructive	Extremely destructive	24.01	953.54	Extremely destructive	Least

In results and discussion section, performance of both Eulerian and Phase-based video magnification methods is analyzed according to mentioned standard performance parameters. But along with them, some basic conditions should be considered while recording input video, such as camera stabilization to avoid contribution in noise because of camera motion or vibrations, suitable light conditions and distance between target and camera for better data acquisition and PSNR. From all these observations and results it can be concluded that the Eulerian video magnification method is fast and simple but supports small amplification factors as noise increases linearly with the amplification factor. The phase video magnification method is comparatively slow and complex but it supports comparatively higher amplification factors and allows motion attenuation for noise reduction. For videos containing large motions of objects, the Eulerian method works fine on a basic level, but the Phase-based method with a motion attenuation algorithm generates better results. In some of the cases, this motion attenuation also distorted the object in the video.

After this performance analysis, it is clear that the proposed method is having some limitations and advantages, while another also has the same and concludes that there is a need to develop a new method of some hybrid approach to overcome the limitations of both methods for better results. A new hybrid method with proper domain-specific implementation can be used to reveal numerous imperceptible signals in normal videos that are invisible to naked eyes. These signals can have small movements or vibrations caused by obstacles. Signals can contain color variations as a reflection of biological activities and many more yet to discover. Devices, software which will be evolved and developed to use this hybrid technique in day to day life would be time-saving, mobile, effective, efficient, at less cost and revolutionary in many aspects.

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