Measuring Heart Rate from Video using EVM

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Abstract - *This project calculates the pulse of a human using simple CCTV footage that can be useful for the medical industry. For this we need a video of a person's face with colour. It also establishes a way to do pulse rate measuring by using an independent component analysis of the mean pixel colour values in the face-centred area of interest (ROI). This theory analyses new methods for selecting the ROI, such as segmenting facial pixels using a reutilization of GrabCut, and is evaluated by the algorithm's effectiveness to subject motion and bounding box noise. The effectiveness of the system against bounding box noise was improved via facial segmentation.*

***Key Words*: Eulerian Video Magnification, GrabCut, ROI, facial segmentation, face detection, frequency analysis, statistical analysis**

1. INTRODUCTION

Eulerian Video Magnification (EVM) is a powerful technique that has gained significant attention in recent years for its ability to amplify subtle visual changes in video sequences. This technique, inspired by the work of Leonhard Euler, a renowned mathematician and physicist, has opened up new possibilities for applications in various fields, including medical imaging, computer vision, and video surveillance.

EVM works by analysing video frames at different temporal frequencies, allowing for the identification and amplification of high-frequency changes that are typically imperceptible to the human eye. These changes can include subtle colour variations, motion patterns, and other visual cues that may hold important information for a particular application.

One of the key strengths of EVM is its ability to enhance videos in real-time, making it suitable for a wide range of real-world applications. Additionally, EVM is a non-invasive technique that can be applied to standard video footage without the need for specialized equipment or markers.

2. AIM OF THE PAPER

In this paper, we will explore the principles behind EVM, its applications in various fields, and its potential limitations. We will also discuss the current state of research in EVM and highlight some recent advancements in the field. Overall, EVM has emerged as a promising technique with the potential to revolutionize how we analyse and interpret video data, opening up new possibilities for a wide range of applications. So, this paper aims to provide an overview of EVM, its principles, applications, and future prospects. So, it is essential to understand the key concepts and advancements in this field in order to fully grasp its potential and implications. Let us delve into the fascinating world of Eulerian Video Magnification. So, this paper aims to provide an overview of EVM, its principles, applications, and future prospects. So, it is essential to understand the key concepts and advancements in this field in order to fully grasp its potential and implications. Let us delve into the fascinating world of Eulerian Video Magnification. So, this paper aims to provide an overview of EVM, its principles, applications, and future prospects. So, it is essential to understand the key concepts and advancements in this field in order to fully grasp its potential and implications. Let us delve into the fascinating world of Eulerian Video Magnification. So, this paper aims to provide an overview of EVM, its principles, applications, and future prospects. So, it is essential to understand the key concepts and advancements in this field in order to fully grasp its potential and implications. Let us delve into the fascinating world of Eulerian Video Magnification. So, this paper aims to provide an overview of EVM, its principles, applications, and future prospects. So, it is essential to understand the key concepts and advancements in this field in order to fully grasp its potential and implications. Let us delve into the fascinating world of Eulerian Video Magnification. So, this paper aims to provide an overview of EVM, its principles, applications, and future prospects. So, it is essential to understand the key concepts and advancements in this field in order to fully grasp its potential and implications. Let us delve into the fascinating world of Eulerian Video Magnification. So, this paper aims to provide an overview of EVM, its principles, applications, and future prospects. So, it is essential to understand the key concepts and advancements in this field in order to fully grasp its potential and implications. Let us delve into the fascinating world of Eulerian Video Magnification. So, this paper aims to provide an overview of EVM, its principles, applications, and future prospects. So, it is essential to understand the key concepts and advancements in this field in order to fully grasp its potential

3. LITERATURE REVIEW

In [1], The authors proposed the EVM algorithm to amplify small changes and motion in objects. This algorithm was used to amplify small vibration in industrial equipment, allowing engineers to conduct preventive maintenance on the equipment. [9] is a python implementation of the EVM algorithm, but due to the bulky nature of python, this algorithm was found to be significantly slower than the MATLAB counterpart. In [2], Neal Wadhwa further works on this algorithm to extract sound from subtle motion in an object, and to characterize material properties. [3] is a review paper on Eulerian Video Magnification, and they identified issues with the current EVM algorithms with respect to computational power and real-time speed. [4] proposes a post-processing method that is applied after current state of the art EVM algorithms that significantly reduces noise in the EVM image, and does not modify the pixel values, so the original data is not destructively altered. In [5], on a variety of captive and untamed species, EVM algorithms have been thoroughly studied. Neotenic Mexican axolotl studies were done to show how heart rate signals of non-embryonic animals can be extracted from specialized video data. Both the high-pressure system of the human and the axolotl's low blood pressure system allow for the measurement of pulse wave velocity. Additionally, heart rate could be extracted from films of aware, unrestrained zebrafish as well as from general videographic footage of giraffes and sand lizards. In [6], a Thermal camera was used to measure subtle changes in the temperature of the body during heartbeats, and the same EVM algorithms were used to amplify those changes. An iPad camera and a thermal camera both recorded video while the subject, was dawning an ECG-collecting textile sensor band, remained motionless. EVM was applied to the iPad video with a wide bandpass filter and a low magnification factor. In [7], they modify the EVM algorithms to be used on a combination of light on the infrared spectrum and the red spectrum, and subtle changes in the reflected intensities are used to measure a person’s SPo2 saturation without any contact with the patient. Their algorithm had an accuracy of 98% with an error of 2%. [8] is a C++ project demonstrating EVM using OpenCV for live video analysis. The project includes a frontend GUI made with Qt and performs basic EVM colour and motion magnification. [9] is a similar project utilizing SciPy and NumPy for the image analysis. Guha Balakrishnan et al. [10] By measuring the head motion brought on by the response to the blood flow at each beat, it was possible to extract the heart rate and beat lengths from films. Their technique tracks the movements of the head's features and breaks down each motion into its component parts. On the basis of its temporal frequency spectrum, it then selects the element that most closely resembles heartbeats. The velocity projected to this component was then examined, and peaks of the trajectories were found that matched heartbeats. YY Boykov et al.

4. PROPOSED METHODOLOGY

Figure 1 gives an overview of the algorithm used for heart rate estimation. The individual steps are:

1. Data collection: Collect CCTV footage of individuals at a suitable distance where facial features are visible, such as a security checkpoint or entrance.
2. Preprocessing: The footage should be pre-processed to remove any artifacts, such as noise or motion blur, that could interfere with the heart rate measurement. This can be done by filtering the video frames and removing any frames that are too blurry or distorted.
3. Face detection: Using a face detection algorithm, identify the regions of interest where the person's face is visible in each frame.
4. Eulerian Video Magnification: Apply the Eulerian Video Magnification algorithm to amplify the subtle colour changes brought by the pulsatile blood flow in the facial regions of interest.
5. Frequency analysis: Use frequency analysis techniques to extract the heart rate signal from the amplified video. This can be done by applying a bandpass filter to the signal to remove noise and unwanted frequencies, and then calculating the heart rate from the remaining frequency peaks.
6. Validation: Validate the heart rate measurement by comparing it with a reference heart rate measurement, such as a pulse oximeter, and assessing the accuracy of the method.
7. Statistical analysis: Utilize statistical analysis to evaluate the method's sensitivity, specificity, and accuracy and contrast it with other methods currently in use to monitor heart rate.

Overall, this methodology provides a non-invasive and remote method for heart rate measurement that can be applied in a range of settings, such as security checkpoints, healthcare, and fitness.

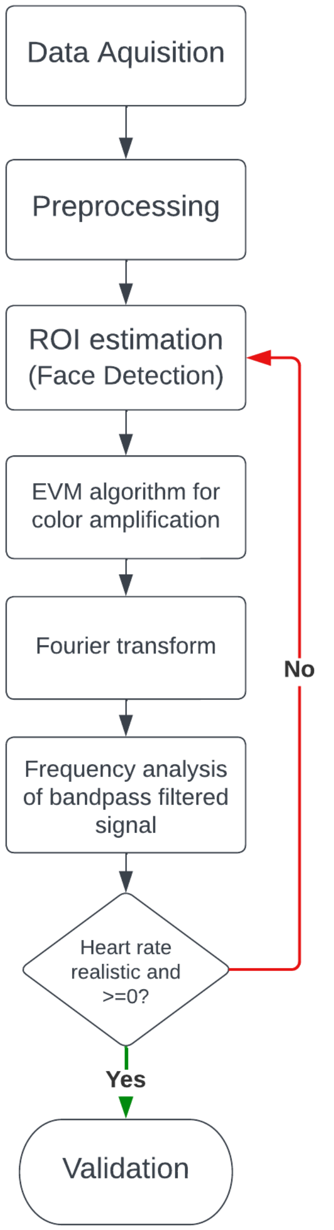

Figure 1: Proposed EVM algorithm for heart rate estimation

5. RESULTS AND DISCUSSION

Figure 2 shows the input footage of a 19 m/o baby was used as input to test the algorithm. Original footage was captured from a regular RGB video camera.

Figure 3 shows the successful ROI estimation and preprocessing of the input RGB video, with the pixel redundancy, noise and artifacts removed.

Figure 2: Freeze frame of input RGB video

Figure 3: ROI estimated output after the preprocessing stage

6. PERFORMANCE OF THE WORK

Figure 4 is the end output video of the baby upon applying the EVM amplified video through red-spectrum bandpass filtering. Performing frequency analysis on the resulting signal, the heart rate of the baby can be estimated. The results displayed were a satisfactory indication of the performance required. However, we are working on ways to make this faster using a different algorithm

Figure 4: Final output video of the baby with the red channel and heart rate estimation

7. CONCLUSION

In this paper, a simple technique was outlined that takes a regular RGB video as an input, and magnifies minute colour variations and undetectable motions. The approach uses spatial-temporal processing instead of performing optical flow computation. This significantly increases the computational efficiency of the code, and allows dynamic allocation of weights, allowing for different levels of magnification based on the nature of the video input.

8. REFERENCES

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