IJRAR.ORG E-ISSN: 2348-1269, P-ISSN: 2349-5138

INTERNATIONAL JOURNAL OF RESEARCH AND ANALYTICAL REVIEWS (IJRAR) | IJRAR.ORG

An International Open Access, Peer-reviewed, Refereed Journal

AN ADAPTIVE IMAGE ENHANCEMENT SCHEME FOR LOW- LIGHT IMAGE

[1]R.Sunitha,[1]S.Sari Kalyani,[1]S.G.V.S.Naveeni,[1]V.Yedukondalu,

[2]K Rajasekhar , [3] N. Phani Kumar

[1]UG Student, [2]Professor, [3]Assistant Professor,

[1,2,3]Department of Electronics and Communication Engineering,

Bonam Venkata Chalamayya Engineering College (Autonomous), Odalarevu, Andhra Pradesh, India.

Abstract

Under unfavorable conditions such as indoor lighting, nighttime environments, and cloudy weather, the reflection of light from target surfaces becomes weak, and image details are often affected by noise, leading to degraded image quality. To address this issue and improve the visibility of low-illumination images, this paper proposes an adaptive image enhancement algorithm based on the Illumination–Reflection model and Multiscale theory. The proposed method first converts the input RGB image into the HSV color space to better separate brightness information from color components. A Multiscale Gaussian function is then applied to estimate the illumination component and enhance brightness effectively.Furthermore, a correction function based on Weber–Fechner's law is utilized to adaptively adjust enhancement parameters according to the characteristics of human visual perception. This helps achieve balanced contrast improvement while avoiding over-enhancement and color distortion. Finally, an image fusion strategy is employed to extract and combine detailed information from multiple scales, producing a final image with improved brightness, enhanced contrast, and clearer details.

Keywords— Low-light image enhancement, Multiscale theory, HSV color space, Image fusion, Contrast enhancement, Noise reduction, Weber–Fechner law, Adaptive enhancement, Human visual perception.

.I .INTRODUCTION

Health is one of the most fundamental challenges for humanity. As the global population increases and the average lifespan rises, traditional healthcare systems are becoming overburdened. In countries like India, cardiovascular diseases have become a leading cause of mortality. Statistics from the Registrar General of India indicate that adult mortality due to heart-related issues rose significantly from 26% in the early 2000s to over 32% by 2013.The primary limitation of traditional medical check-ups is that they provide only a "snapshot" of a patient's health. Many cardiac arrhythmias or blood pressure spikes occur intermittently and may not be present during a brief hospital visit. Therefore, there is an urgent requirement for a Real-Time Remote Health Monitoring System.The Role of IoT in Healthcare: The Internet of Things (IoT) refers to the network of physical devices embedded with sensors, software, and connectivity, allowing them to collect and exchange data. In this project, IoT is applied to create a "Health Line" service. By

attaching biomedical sensors (ECG, Temperature, Heart Rate) to a patient's body, vital signs can be digitized and transmitted wirelessly to a cloud platform.

II. RELATED WORK

Recent studies have focused on improving low-light videos and images captured under poor illumination conditions. Image enhancement techniques are broadly categorized into two types:

- **Spatial Domain Methods:** Directly manipulate image pixels. They are simple to understand with low complexity, making them suitable for real-time applications.
- **Frequency Domain Methods:** Manipulate Fourier transforms of an image. These offer advantages like easy viewing of frequency composition and low computational complexity for specific tasks.

Enhancement methods can be further classified into seven classes: Gray Transformation, Histogram Equalization (HE), Retinex, Frequency-Domain, Image Fusion, Defogging models, and Machine Learning. Each has specific merits and shortcomings, such as Gray Transformation's low complexity versus its tendency to lose details.

III. PROPOSED SYSTEM ARCHITECTURE

The proposed system uses an adaptive enhancement scheme based on the Illumination-Reflection model and Multiscale theory.

- **Colorspace Conversion:** The input RGB image is converted to the **HSV** colorspace using a Multiscale Gaussian function.
- **Adaptive Adjustment:** A correction function based on **Weber-Fechner's law** is applied to illumination components. This allows enhancement parameters to be adjusted adaptively based on light distribution profiles.
- **Image Fusion:** Key details are extracted and merged using an Image Fusion strategy.
- **Reconstruction:** The final image is converted back to RGB, resulting in cleaner, brighter details compared to conventional algorithms.



Figure 1 alpha 0.3

IV. HARDWARE DESIGN

 Hardware Requirements: A Personal Computer with a 64-bit i5 processor or higher, at least 8GB of RAM, and integrated graphics.

 Software Requirements: Windows 10 or above operating system.

 MATLAB: The core development was done in **MATLAB 2022b**, a high-performance language for technical computing used for matrix manipulation and image processing.

V. WORKING PRINCIPLE

It begins at the sensor layer, where biomedical components like the AD8232 ECG sensor and LM35 temperature sensor are placed on the patient's body to detect biopotential heart signals and thermal energy. These sensors capture data as analog electrical voltages, which are then transmitted to the Arduino UNO. The microcontroller uses its internal Analog-to-Digital Converter (ADC) to translate these raw voltages into clinical units, such as Beats Per Minute (BPM) and degrees Celsius.

Once the data is processed, the ESP8266 Wi-Fi module establishes a connection to the internet via a local access point and pushes the digitized health metrics to the Blynk Cloud Server using the TCP/IP protocol. This architecture allows the information to be accessed globally in real-time. Finally, the data is visualized on the Blynk Mobile Application, where it is presented through live scrolling ECG graphs and digital gauges. The system is designed with a safety threshold logic; if any vital sign (like an elevated heart rate or high fever) crosses a predefined limit, the cloud server automatically triggers an instant push notification or email alert to medical professionals or family members, enabling immediate emergency intervention.

.VI. EXPERIMENTAL RESULTS

Information Entropy (IE), which is used to quantitatively measure the richness of details and information content in the images before and after enhancement.

Image Name	Original Image	Enhanced Image	Improvement (%)
Seminar Hall	6.4869	7.0869	+9.2%
Petro Park	5.4403	7.0204	+29.0%
Street	4.9551	7.1076	+43.4%

Information Entropy (IE) Results

VII. CONCLUSION

The proposed adaptive image enhancement scheme effectively improves image quality under low-light conditions by integrating multiscale fusion techniques with illumination–reflection modeling. This approach enhances brightness and contrast while preserving important image details and reducing noise. Compared to traditional RGB-based enhancement algorithms, the proposed method demonstrates superior performance in maintaining natural color representation and fine structural information.

Furthermore, the adaptive nature of the scheme allows it to handle varying illumination levels more efficiently, making it suitable for real-world applications such as surveillance systems, medical imaging, autonomous vehicles, and photography..

REFERENCES

1] C. Lee et al., "Contrast enhancement based on layered difference representation," IEEE Trans. Image Process, 2013.

[2] M. Abdullah-Al-Wadud et al., "A dynamic histogram equalization for image contrast enhancement," IEEE Trans. Consum. Electron, 2007.

[3] X. Guo et al., "LIME: Low-light image enhancement via illumination map estimation," IEEE Trans. Image Process, 2017.

[4] X. Fu et al., "A weighted variational model for simultaneous reflectance and illumination estimation," CVPR, 2016.

[5] Z. Ying et al., "A new image contrast enhancement algorithm using exposure fusion framework," CAIP, 2017.

6] K. He, J. Sun, and X. Tang, “Single image haze removal using dark channel prior**,”** IEEE Transactions on Pattern Analysis and Machine Intelligence**,** vol. 33, no. 12, pp. 2341–2353, 2011.

[7] E. H. Land, “The Retinex theory of color vision,” Scientific American, vol. 237, no. 6, pp. 108–128, 1977.

[8] D. J. Jobson, Z. Rahman, and G. A. Woodell, “A multiscale Retinex for bridging the gap between color images and the human observation of scenes**,”** IEEE Transactions on Image Processing, vol. 6, no. 7, pp. 965–976, 1997.

[9] K. Simonyan and A. Zisserman, “Very deep convolutional networks for large-scale image recognition,” International Conference on Learning Representations (ICLR**)**, 2015.

[10] C. Wei, W. Wang, W. Yang, and J. Liu, “Deep Retinex decomposition for low-light enhancement,” British Machine Vision Conference (BMVC), 2018.

[11] W. Wang et al., “Underexposed photo enhancement using deep illumination estimation,” IEEE Conference on Computer Vision and Pattern Recognition (CVPR)**,** 2019.