

## ***An Integrated Approach for Intruder Detection in Nighttime Surveillance***

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In nighttime surveillance, accurate human detection and recognition are crucial yet challenging, especially in low-light environments. This study proposes a comprehensive solution for intruder detection, focusing on three stages: image enhancement, human detection, and human (face) recognition. The primary challenge addressed is the significant drop in surveillance accuracy in low-light conditions, where traditional systems often struggle. Firstly, a hybrid image enhancement approach was employed for images captured at 1280x720 resolution from CCTV video of a domestic environment to improve low-light visibility. Utilizing the Contrast Enhancement Algorithm Based on Gap Adjustment for Histogram Equalization (CegaHE), visibility in low-light images was improved by evenly distributing the lower side of the image histogram. This is followed by contrast-limited adaptive histogram equalization (CLAHE), which adjusts the over-enhanced areas of the improved image, providing a balanced light correction. This integrated approach ensures effective operation under low-light conditions. Secondly, enhanced images are processed using SSD MobileNet V2, a lightweight but effective deep learning model, to detect humans with high precision. This method reduces false positives and guarantees accurate human identification. Finally, to recognize home-dwellers from intruders, the detected human was further processed using a fine-tuned Siamese network with triplet loss, capable of face recognition. This network was trained using a dataset of face images belonging to three home-dwellers, and at deployment, it was able to reliably identify the home-dwellers while enduring changes in lighting and occlusion. The proposed system architecture significantly improves intruder detection in nighttime surveillance, achieving a detection accuracy of 90.625% compared to 89.0% accuracy achieved by the state-of-the-art ARCFace model. In conclusion, this integrated approach highlights the novel contributions of image enhancement, robust human detection, and precise face recognition during nighttime, combining advanced artificial intelligence, machine learning, and computer vision to establish a highly efficient nighttime surveillance system.

**Keywords:** Nighttime Surveillance, Image Enhancement, Intruder Detection, Human Recognition, Siamese Network, Triplet Loss