Automatic brightness control in near-infrared spectrum using approximate face region detection

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1. Introduction

- Face analysis: important human face information is extracted
  - High-quality input face image needed in both low and high illumination conditions -> near-infrared (NIR) spectrum
- Obtain high-quality NIR face image -> automatic brightness control with approximate face region detection
  - Face region brightness adjustment
  - Accurate, fast, and suitable for real-time embedded system implementation
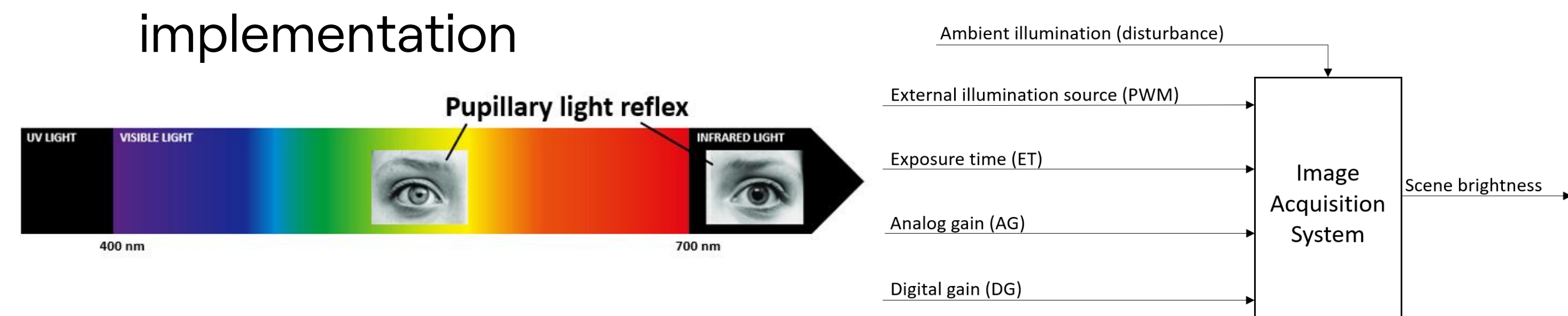

2. Problem Description

- Face analysis tasks: complex and resource-hungry
- Fast and resourceful preprocessing task improves the face image quality while not affecting the overall performance
 - Convenient in a system with limited resources

3. Methodology

- The proposed method consists of two segments:
  - Automatic brightness control
    - split-range PID controller where four different control signals are controlled with a single control variable and four weighting factors
  - Face region detection
    - Spatial part
      - Face region boundaries calculated in the current step
    - Temporal part
      - Previous boundaries included in new boundary calculation to prevent sudden region changes
- Face absence handle eliminates the sudden brightness changes when face (dis)appears in a scene
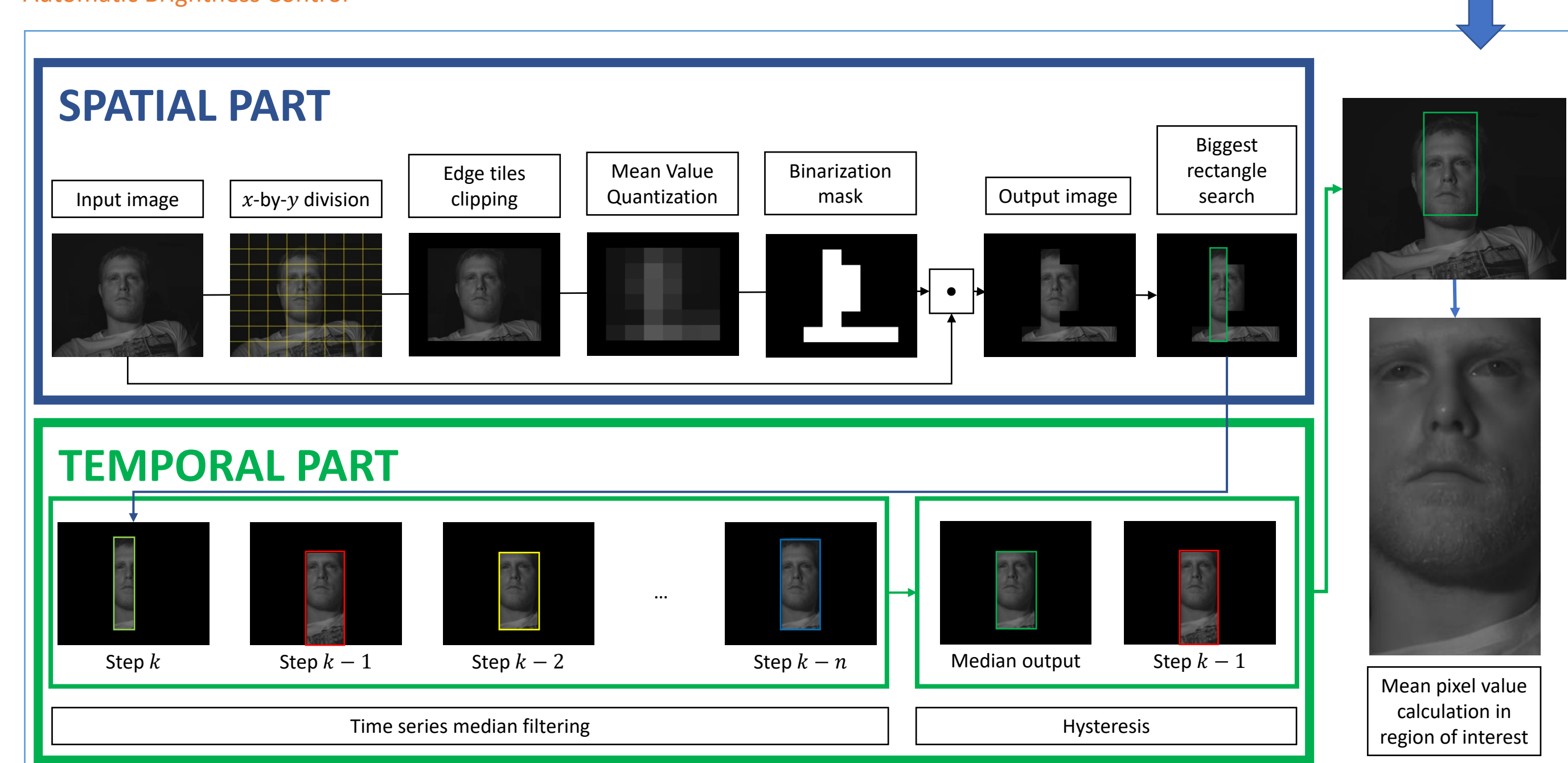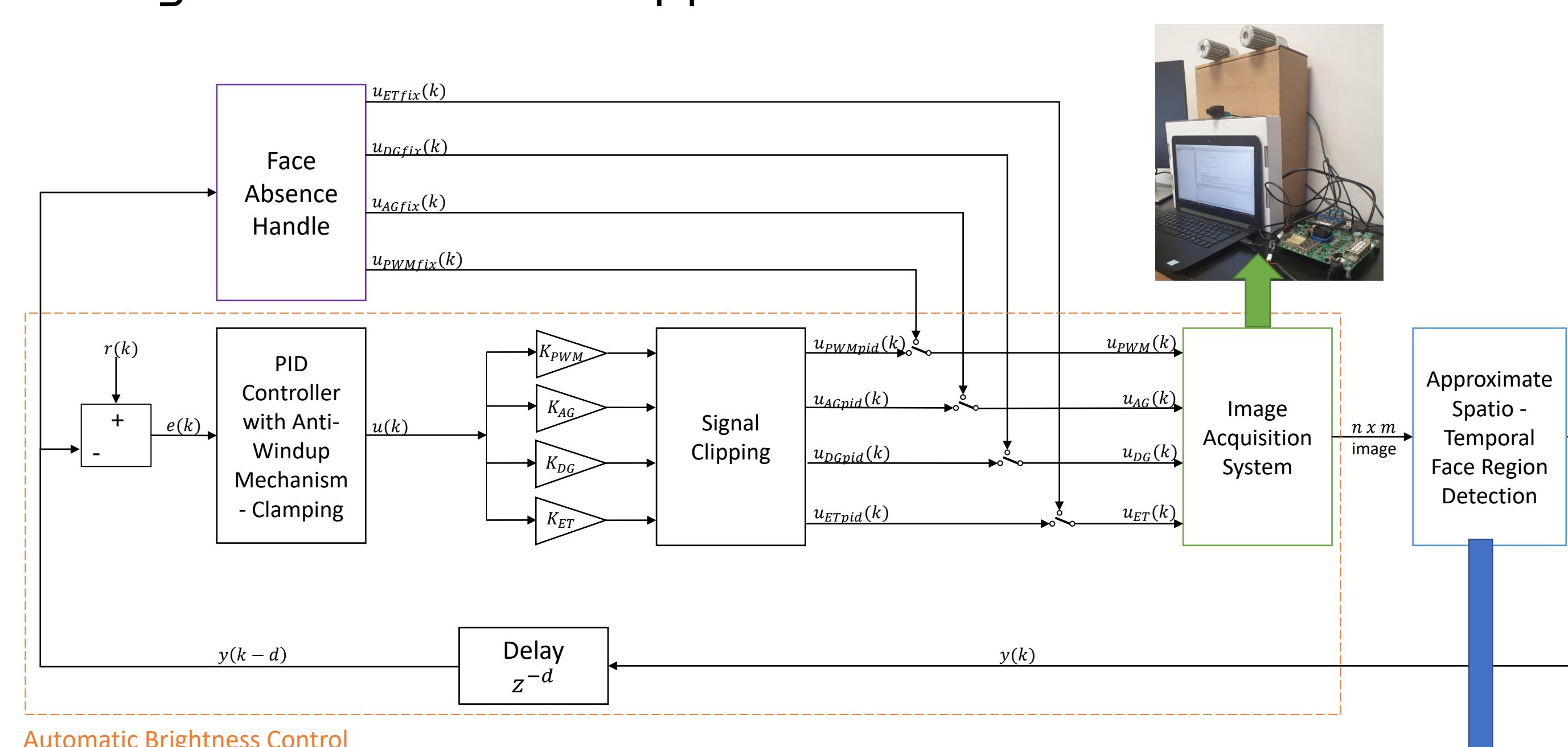
4. Results

- The proposed method performance tested on the Xilinx ZCU104 embedded system
- The face region detection compared to the Viola-Jones face detection algorithm
  - satisfactory detection rate and very fast execution speed
- The automatic brightness control algorithm performance tested in different scenarios -> very fast and robust response
- The face absence handle module works well when the face disappears from a scene

Face region detection algorithms comparison		
Algorithm	F1-score [%]	Execution time [ms]
Viola-Jones	68.24	41.65
Proposed method	63.94	1.65
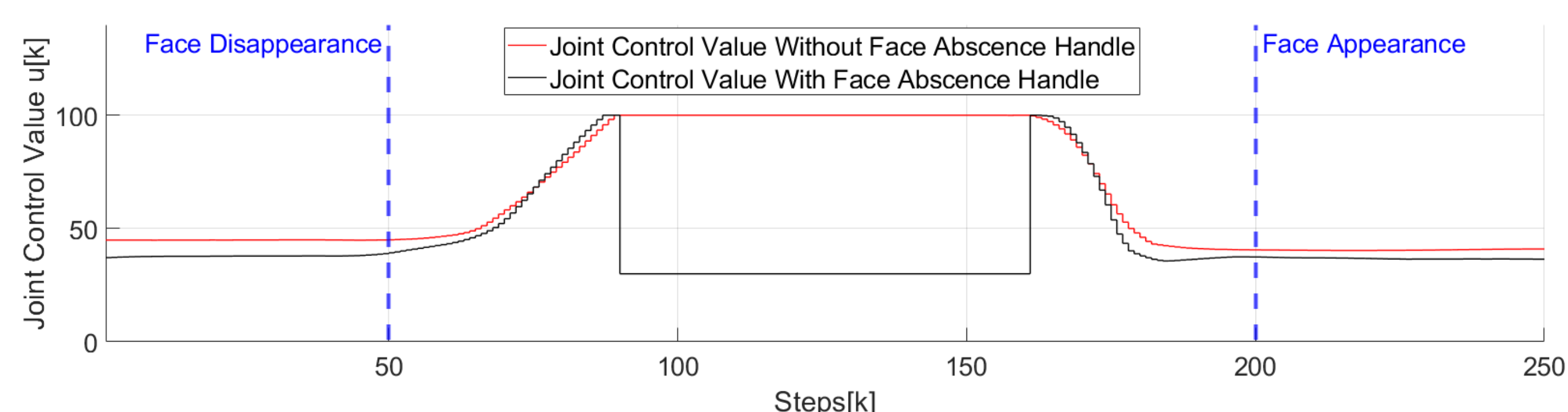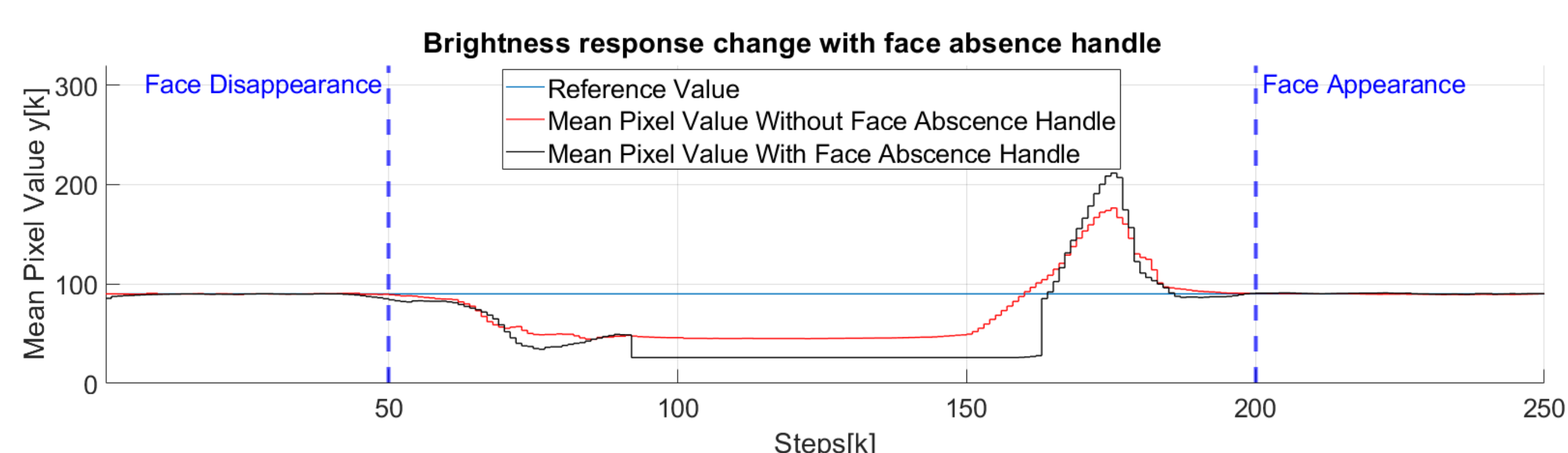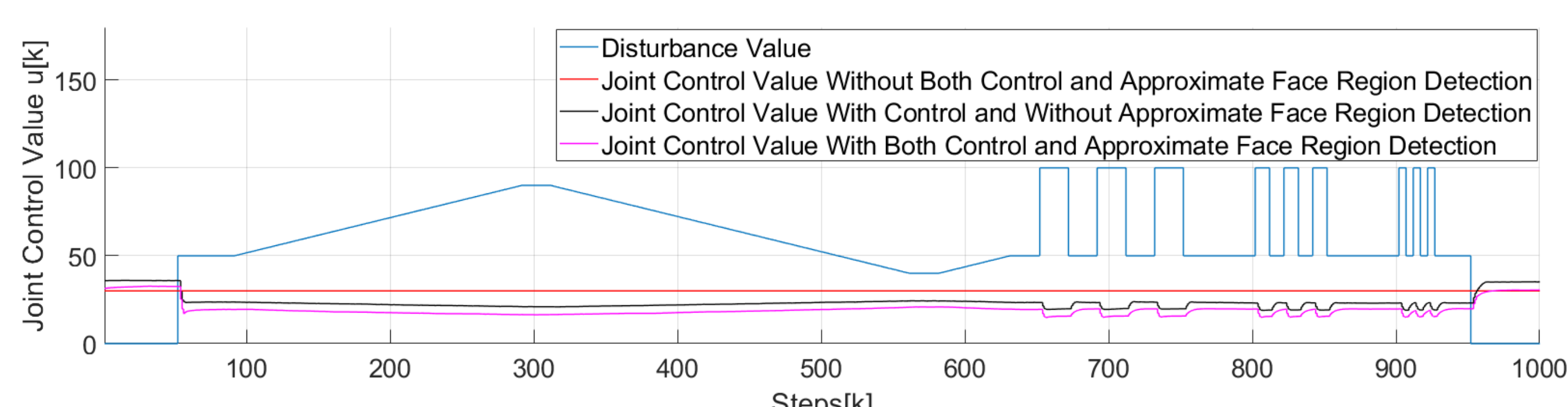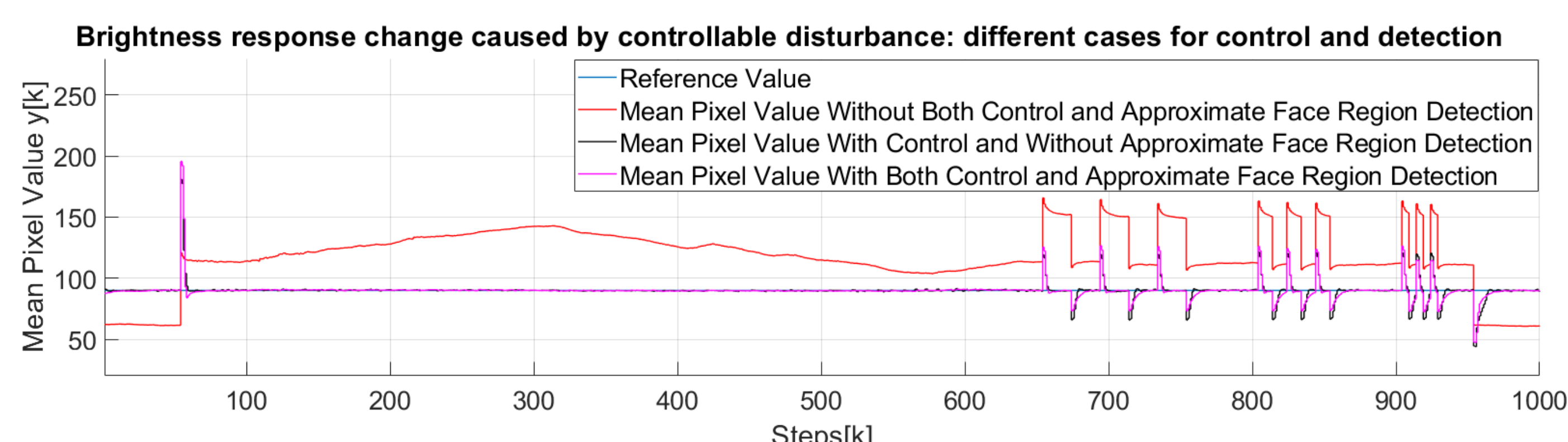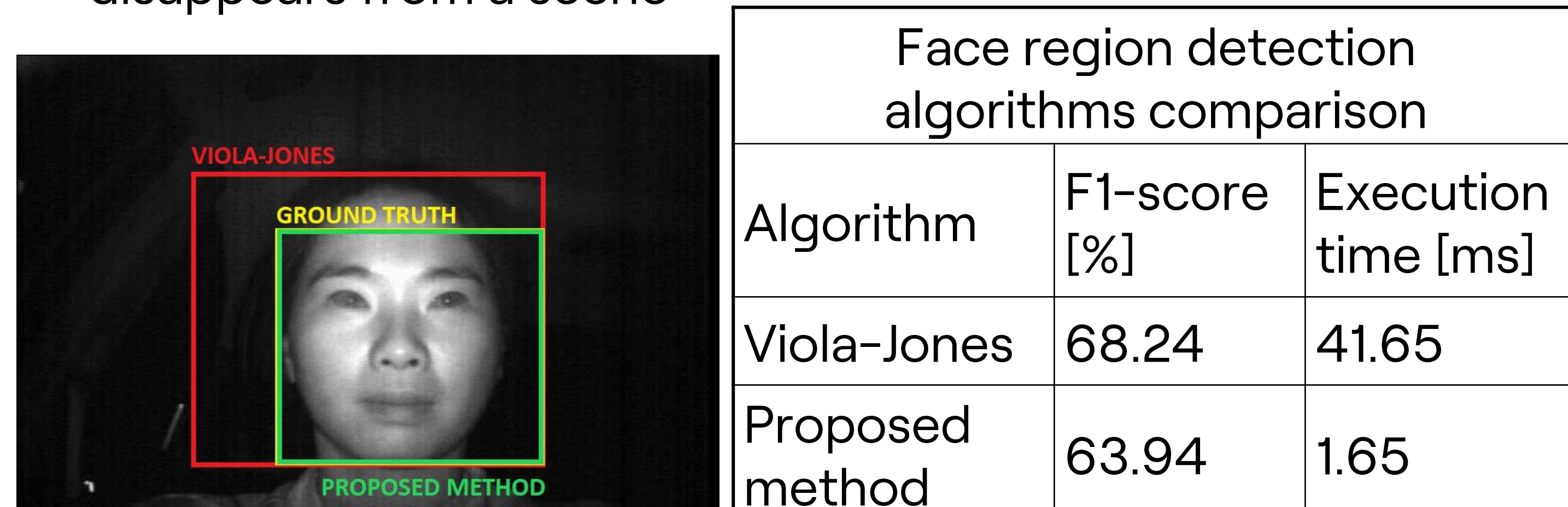
5. Conclusion

- The proposed method successfully adjusts the face region brightness
- Detection performance insignificantly lower than the Viola-Jones face detection algorithm while being much faster
- The face region detection and face absence handle greatly improve the performance of the algorithm and reduce equipment wear
- Well-suited for real-time embedded systems implementation

Contact

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