Università
di Genova

Computer Engineerig

Project Exam n°7

Multimodal Systems

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March, 2025

Contents

1 Introduction

The project focuses on the development of a rehabilitation application that tracks the variation of the bounding rectangle's edges surrounding a user in real-time. This application calculates the displacement of the left and right edges over a fixed time interval (40 ms) and visually highlights these changes using graphical overlays in EyesWeb. This report outlines the implementation process, from sensor selection to system architecture and prototype development.

2 Sensor Selection and Data Acquisition

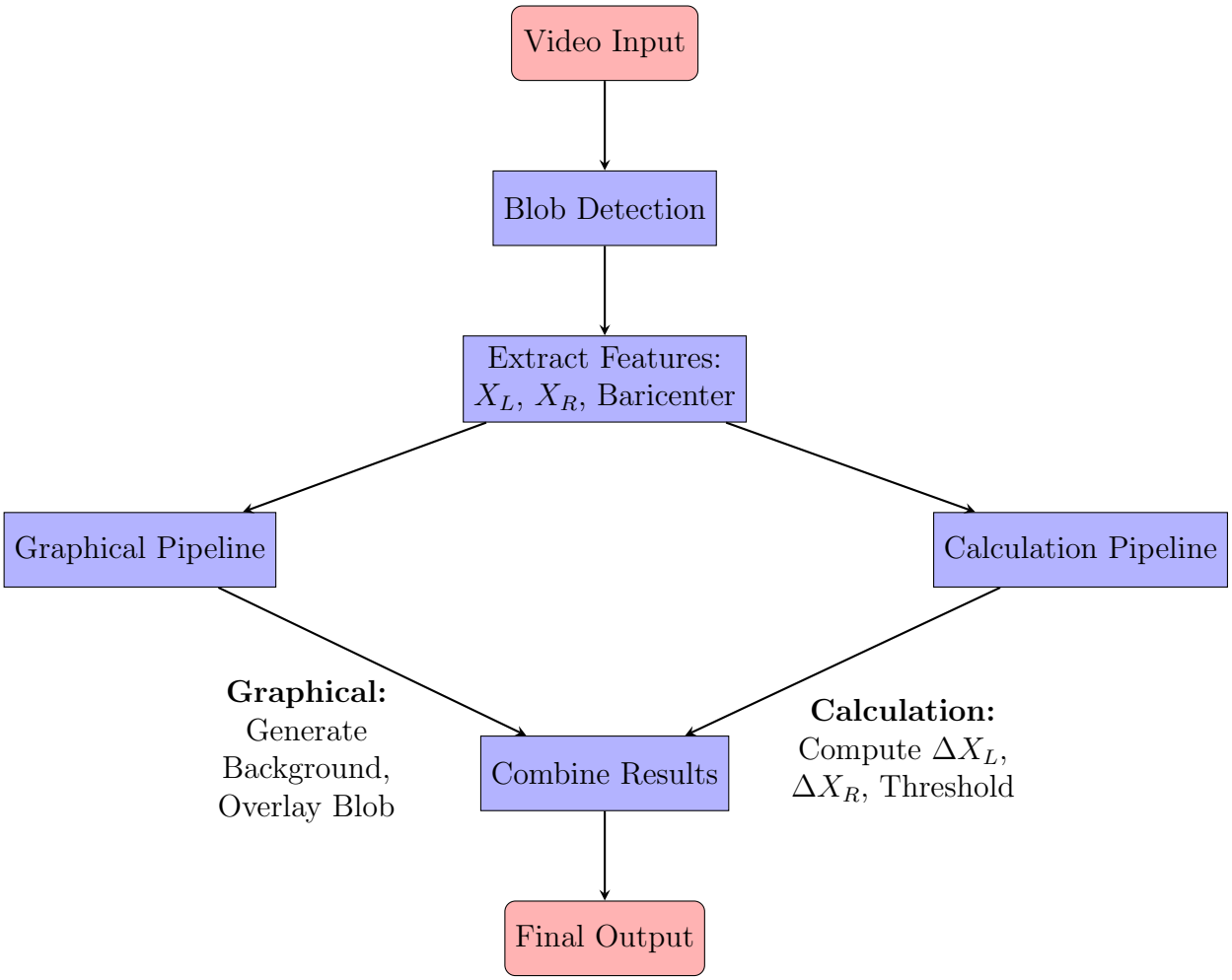
For this project, a video camera was used to track the user's movements in real-time. Other sensors, such as depth cameras like Microsoft Kinect or motion capture systems like Vicon, were considered for their ability to capture 3D data, but a standard video feed was chosen as it offered a good balance between simplicity and effectiveness.

Blob detection was used to identify the user in the video, separating them from the background. The system calculated important features, such baricenter and bounding rectangle, to determine the middle left coordinates and middle righ coordinates of bounding rectangle (X_L and X_R). These values were essential for measuring edge movements and controlling the background color changes.

Video test was chosen for its simplicity and easy integration into multimodal systems. In the future, adding depth sensors could improve accuracy and allow for 3D tracking, making the system more robust in different lighting conditions or complex scenarios.

The sampling rate was set at 40 ms (25 Hz) as present in the specification to ensure smooth and efficient real-time processing without delays.

3 System Design and Critical Aspects



The system architecture is divided into two main pipelines:

- **Calculation Pipeline:** This pipeline computes the variation of the bounding rectangle's left (ΔX_L) and right (ΔX_R) edges using the coordinates X_L and X_R. The values are stored in a queue with a delay of 40 ms, and the absolute difference is calculated to detect variations. A threshold mechanism was implemented to compare the results and generate a boolean output. This boolean value dictates the background color change (red or black) for each side.

- **Graphical Pipeline:** The baricenter of the detected user divides the

background into left and right sections. Monochromatic image generators create red and black backgrounds. Using an OR operator, the system overlays the blob onto the appropriate background based on the boolean value from the calculation pipeline. Finally, the left and right sections are combined to produce the final visualization.

4 Implementation and Prototyping in EyesWeb

The EyesWeb platform was used to develop the prototype. The following steps outline the implementation process:

1. A blob detection module was utilized to extract the bounding rectangle from the video feed.
2. Calculations for x_L and x_R variations were implemented with a queue structure to maintain temporal data.
3. Thresholding logic was applied to trigger the background color change.
4. Graphical modules were configured to generate and overlay red and black backgrounds based on the calculation results.
5. The system output was synthesized by combining the left and right visual components.

5 Results and Discussion

The system successfully tracked the variations in the bounding rectangle's edges in real-time and provided a clear visual indication of these changes. The integration of calculation and graphical pipelines allowed for efficient and accurate feedback, making the system suitable for rehabilitation scenarios.

Critical challenges included optimizing blob detection for dynamic lighting conditions and ensuring synchronization between the calculation and graphical modules.

6 Conclusion

This project demonstrated the feasibility of using EyesWeb for real-time tracking and visualization of user movements in rehabilitation applications. The modular design and integration of calculation and graphical pipelines offer a versatile framework for further development and customization.