Department of Physics and Instrumentation
Engineering
National Institute of Applied Science and Technology

Visual Servoing of A Line Following Robot

Project
Presentation

Personal Professional Project

in

Industrial IT and Automation Engineering (IIA 3)

by

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Overview

Introduction

Statistics

1.3 million annual road traffic deaths.

Problem

Human drivers struggle with maintaining lane position

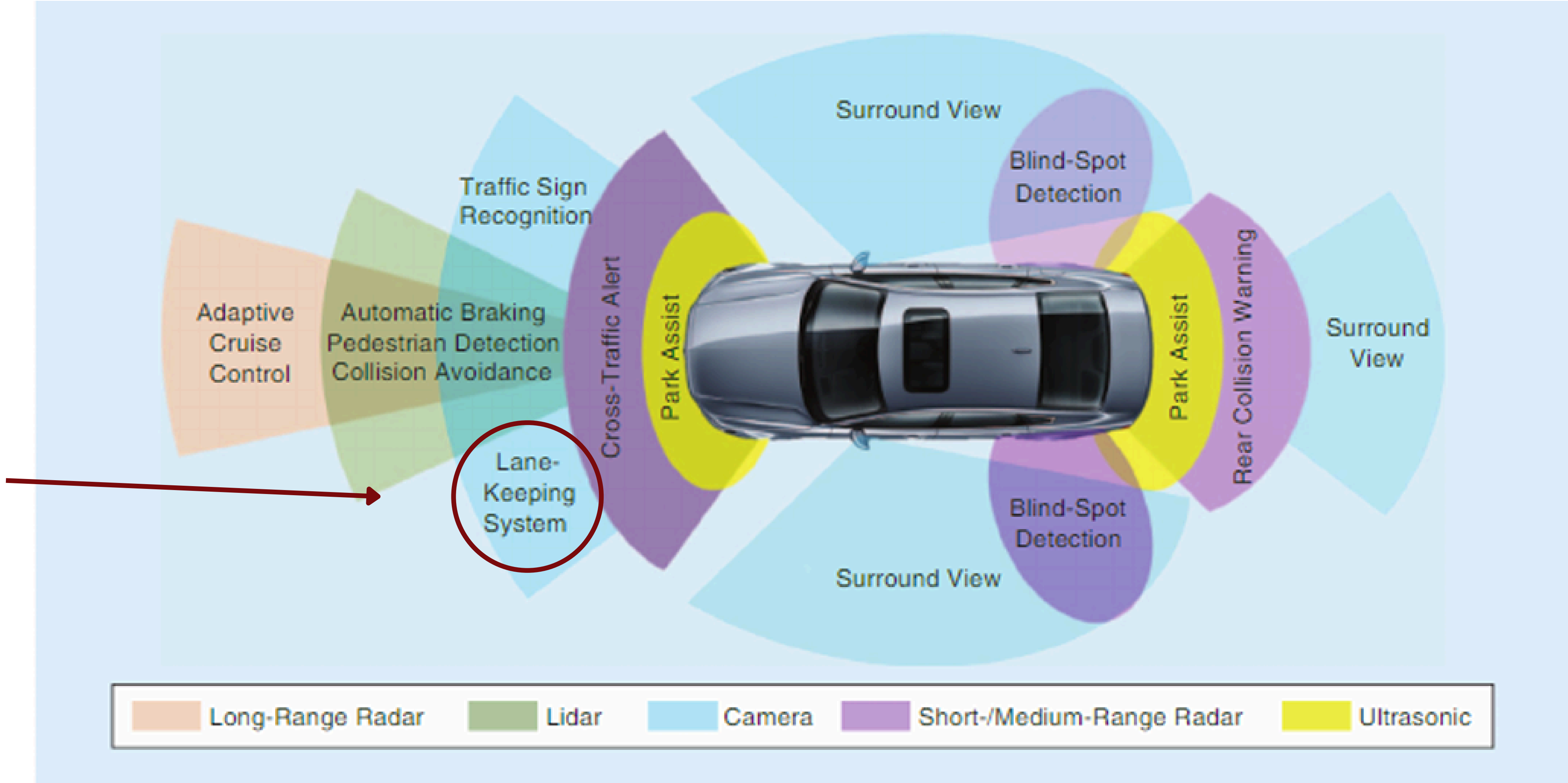
Solution

ADAS enhances vehicle safety.

Our Study

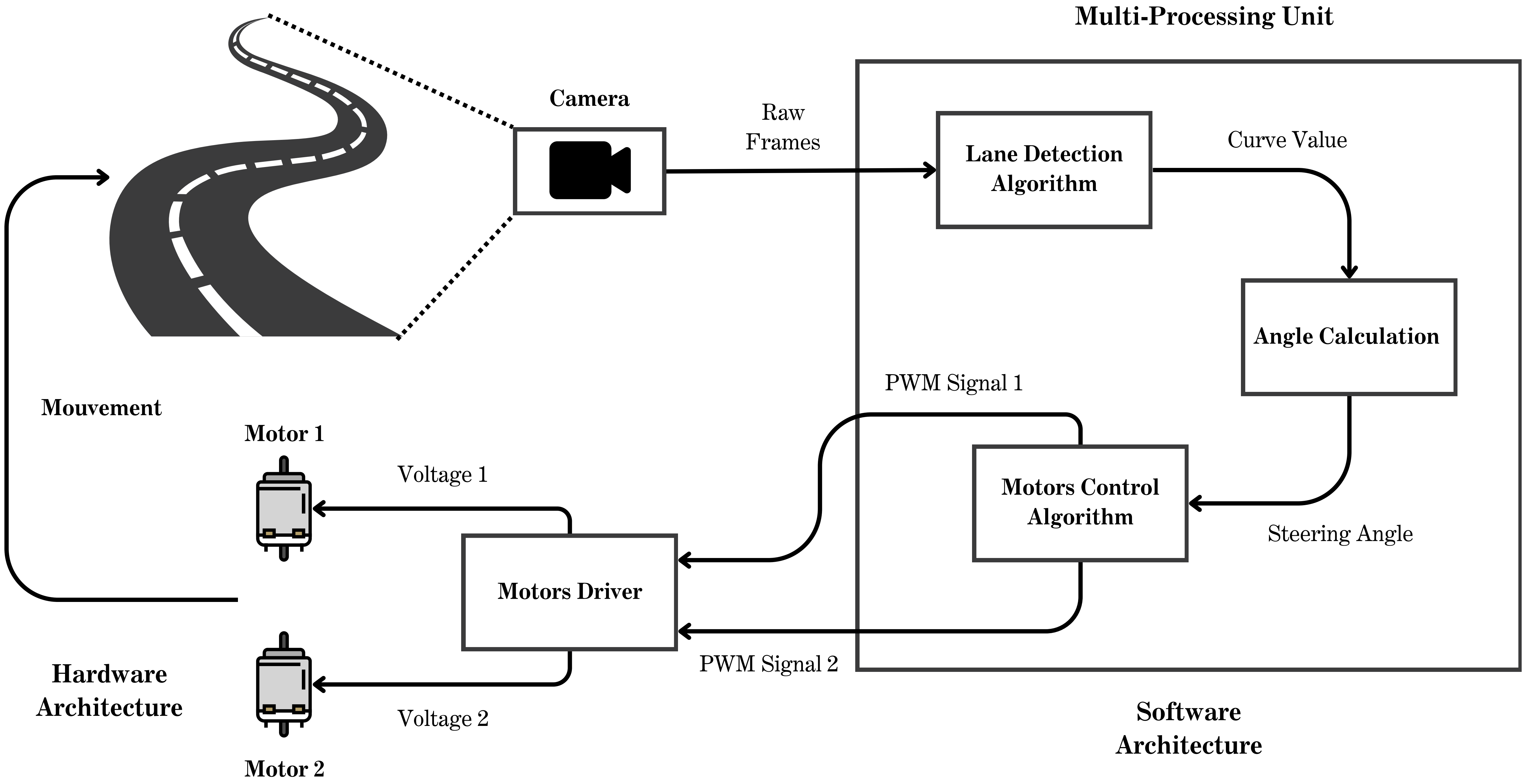
Part of the ADAS, Lane Detection and Lane Keeping

Lane keeping and detection system uses a Camera as a sensor.



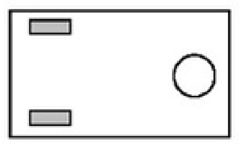
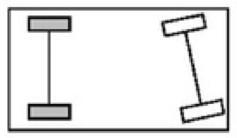
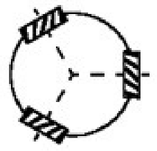
Sensors used by the ADAS (Advanced Driver-Assistance System)

System Design



Comprehensive System Diagram (Hardware and Software)

Mechanical Design

Configuration	Description	Advantages	Disadvantages	Application	Arrangement
2-Wheeled Differential Robot	Two driven wheels with a ball caster wheel for support	Simple construction, cost-effective, high maneuverability, can pivot in place	Limited stability on uneven terrain, requires precise balance	Indoor navigation, educational robotics	
4-Wheeled Robot	Two motorized wheels in the back, 2 steered and free wheels in the front	Stable, good traction, high load capacity	Complex control, less maneuverable	Outdoor exploration, industrial	
3-Wheeled Robot	Three motorized Swedish or spherical wheels arranged in a triangle	omnidirectional movement is possible	Complex control	Autonomous delivery, mobile robotics	

Comparative table between different robot wheel configurations, their descriptions, advantages, disadvantages and applications.

Mechanical & Electrical Design

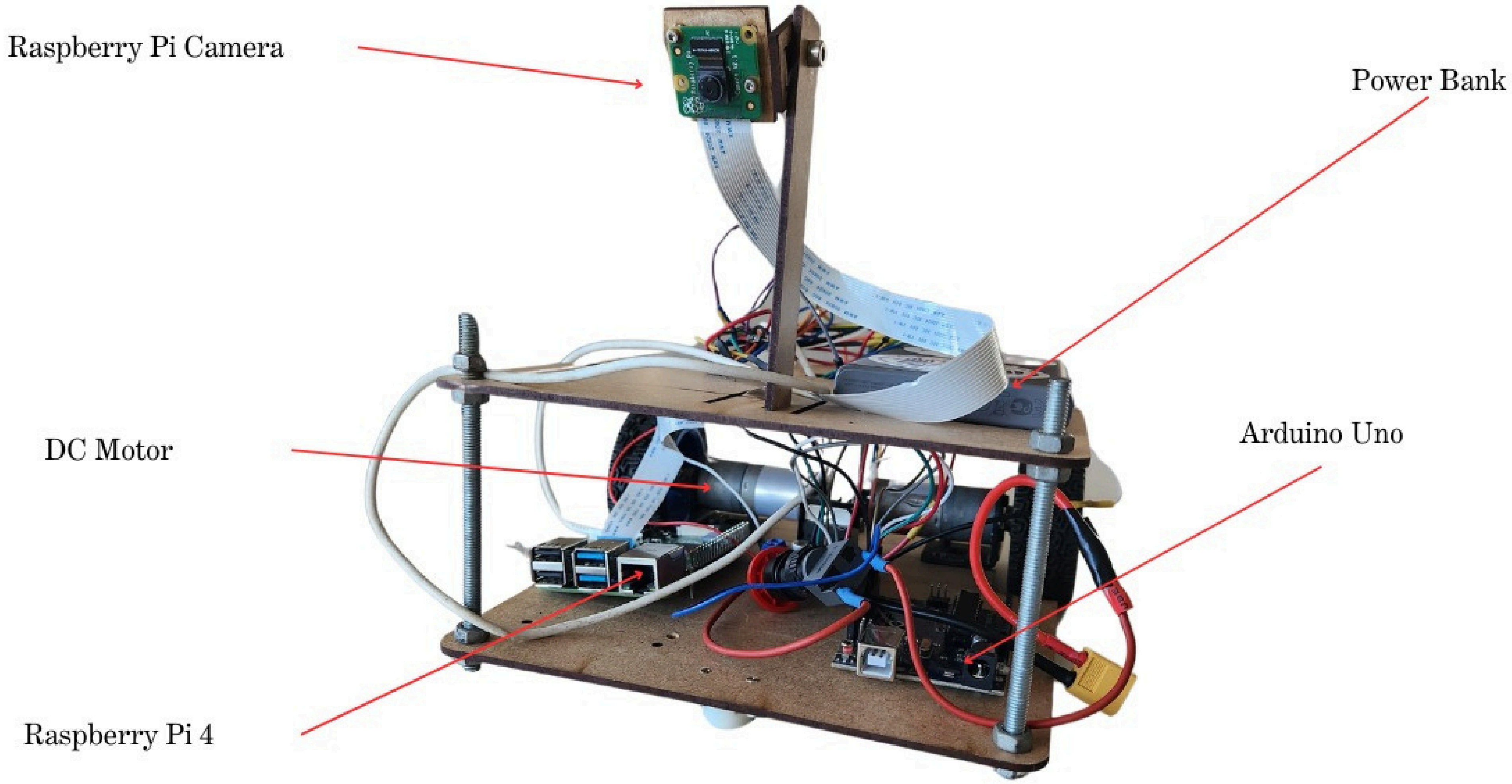
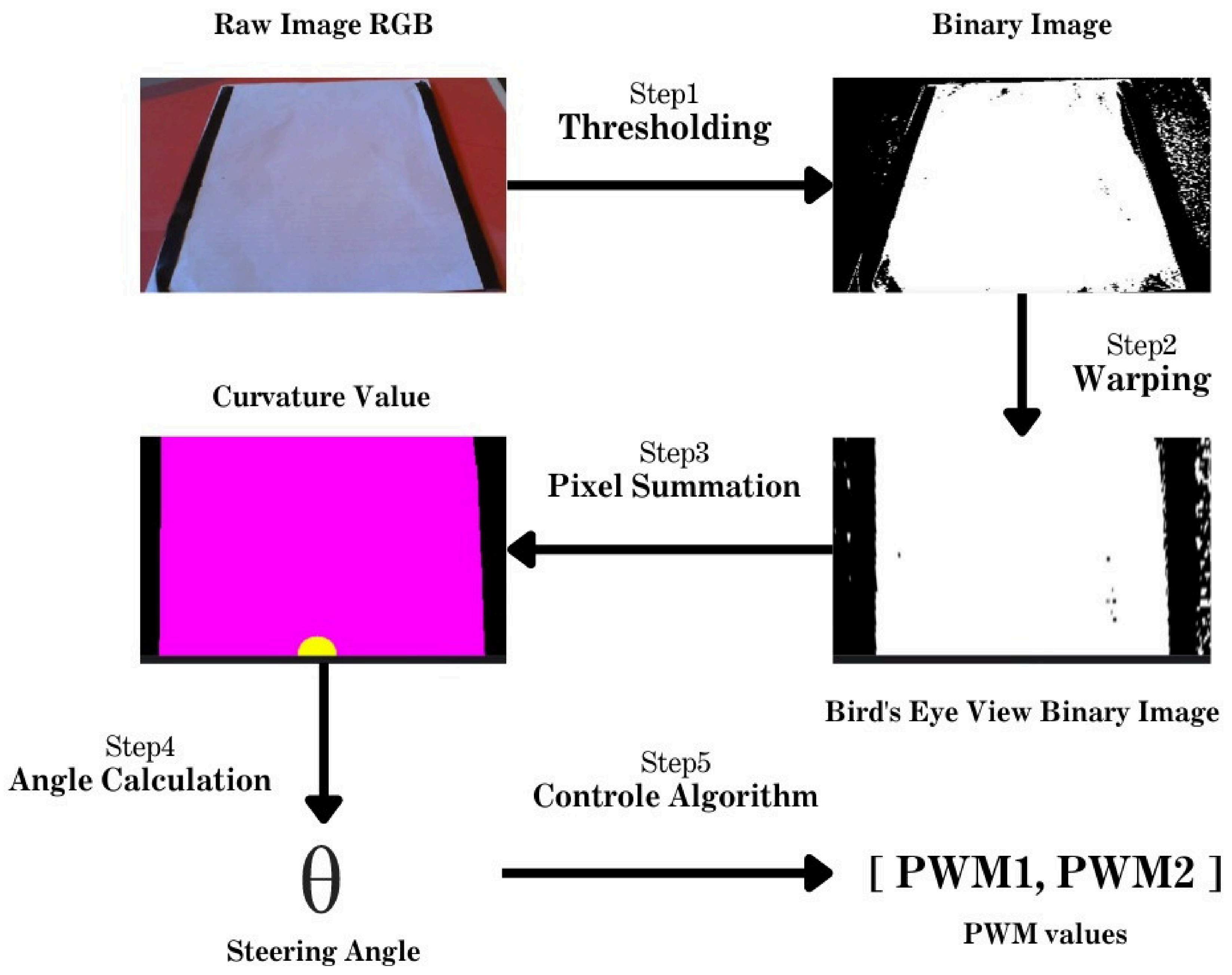


Image of the Prototype

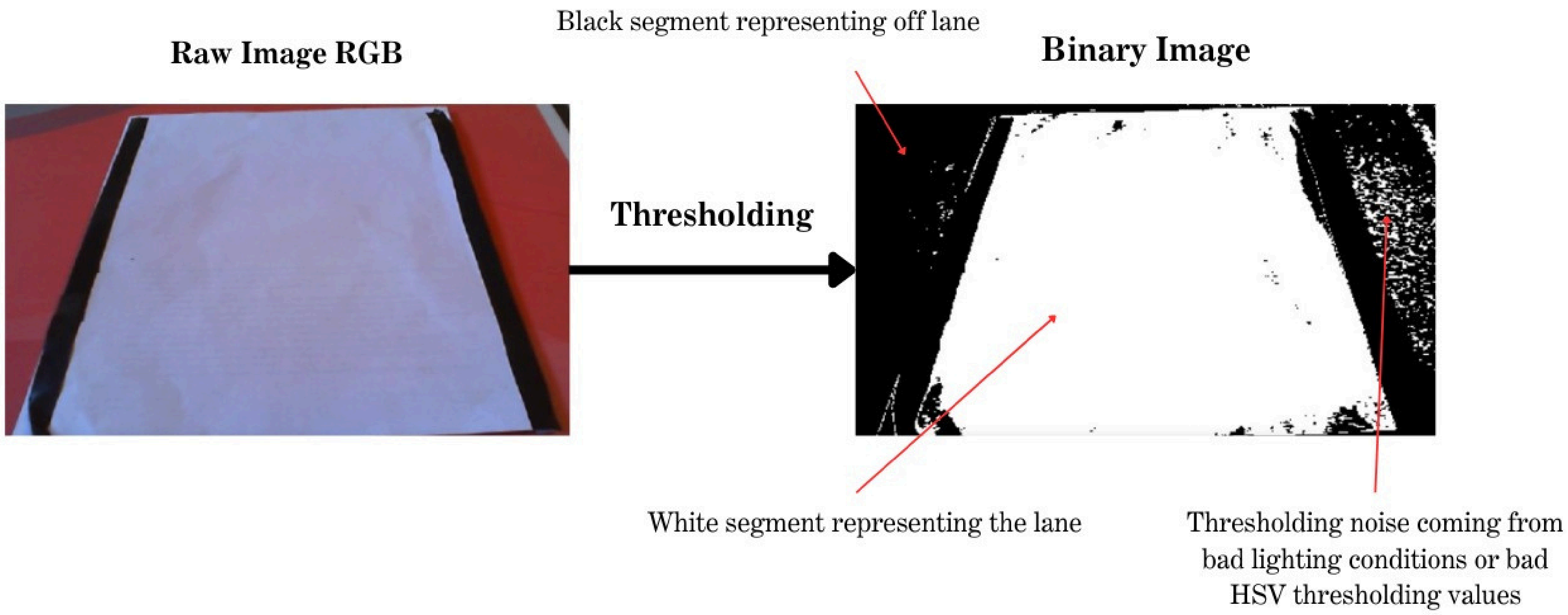
Software Design



Simplified illustration of the relationship between the different software stages

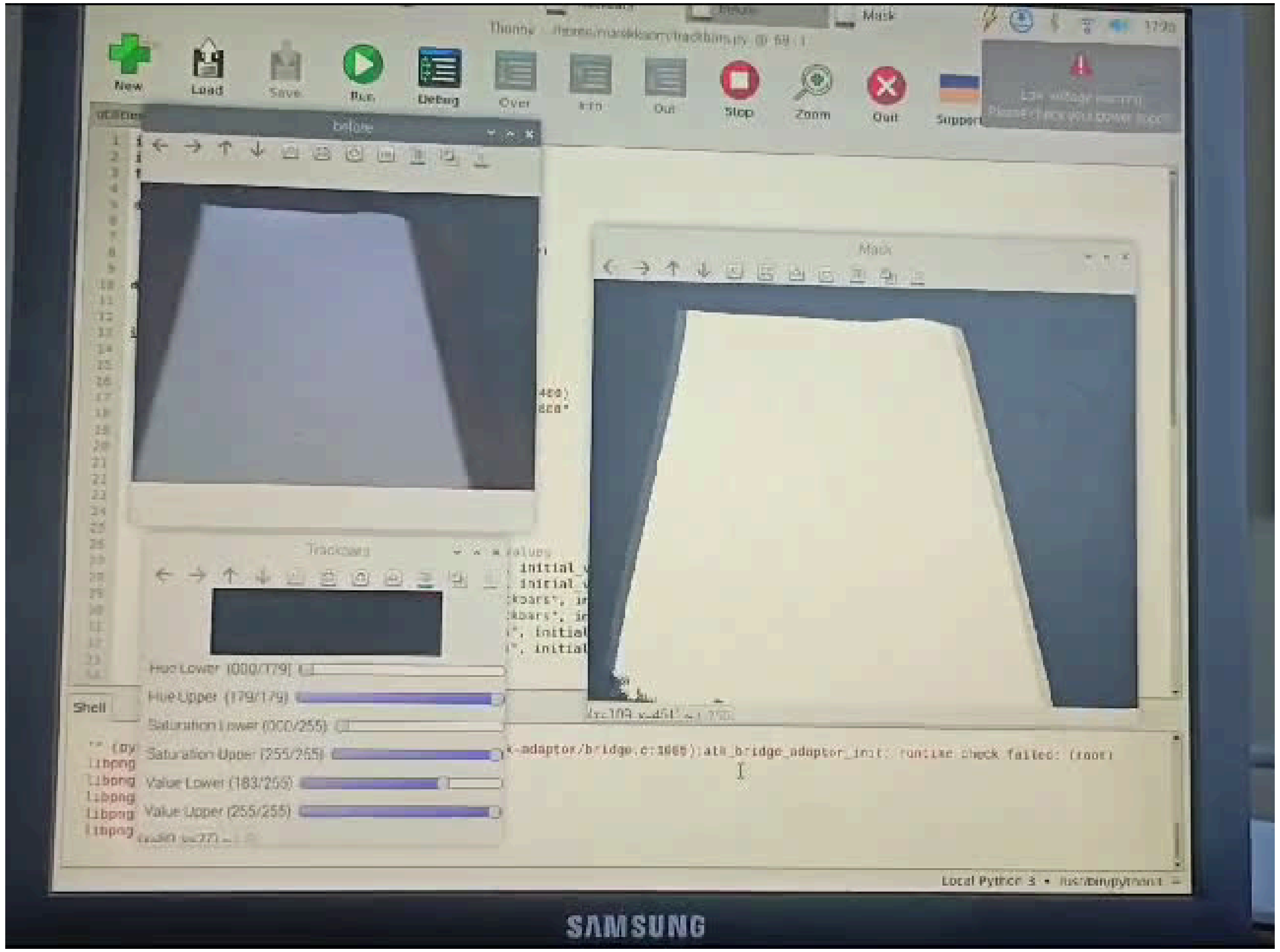
Thresholding

Thresholding is an image segmentation technique that assigns pixel values based on a given threshold.



Example that illustrates the thresholding process, the left image is the original and the right image is the thresholded image.

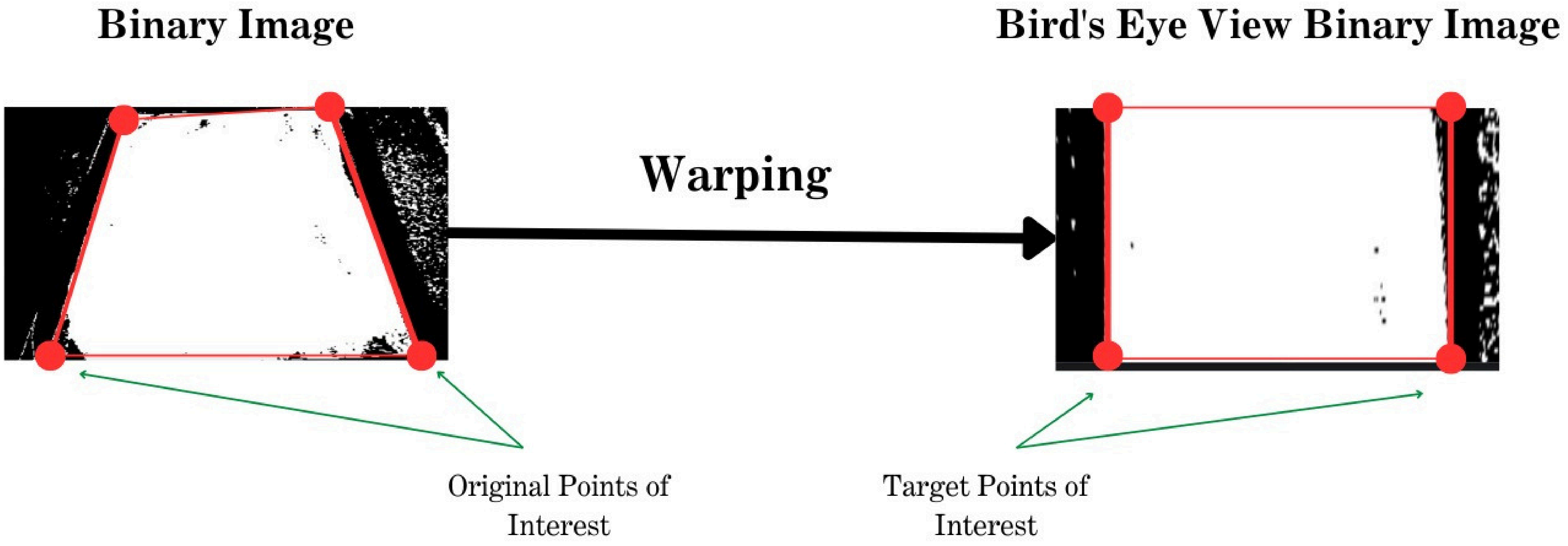
Thresholding



Example of real-time Thresholding

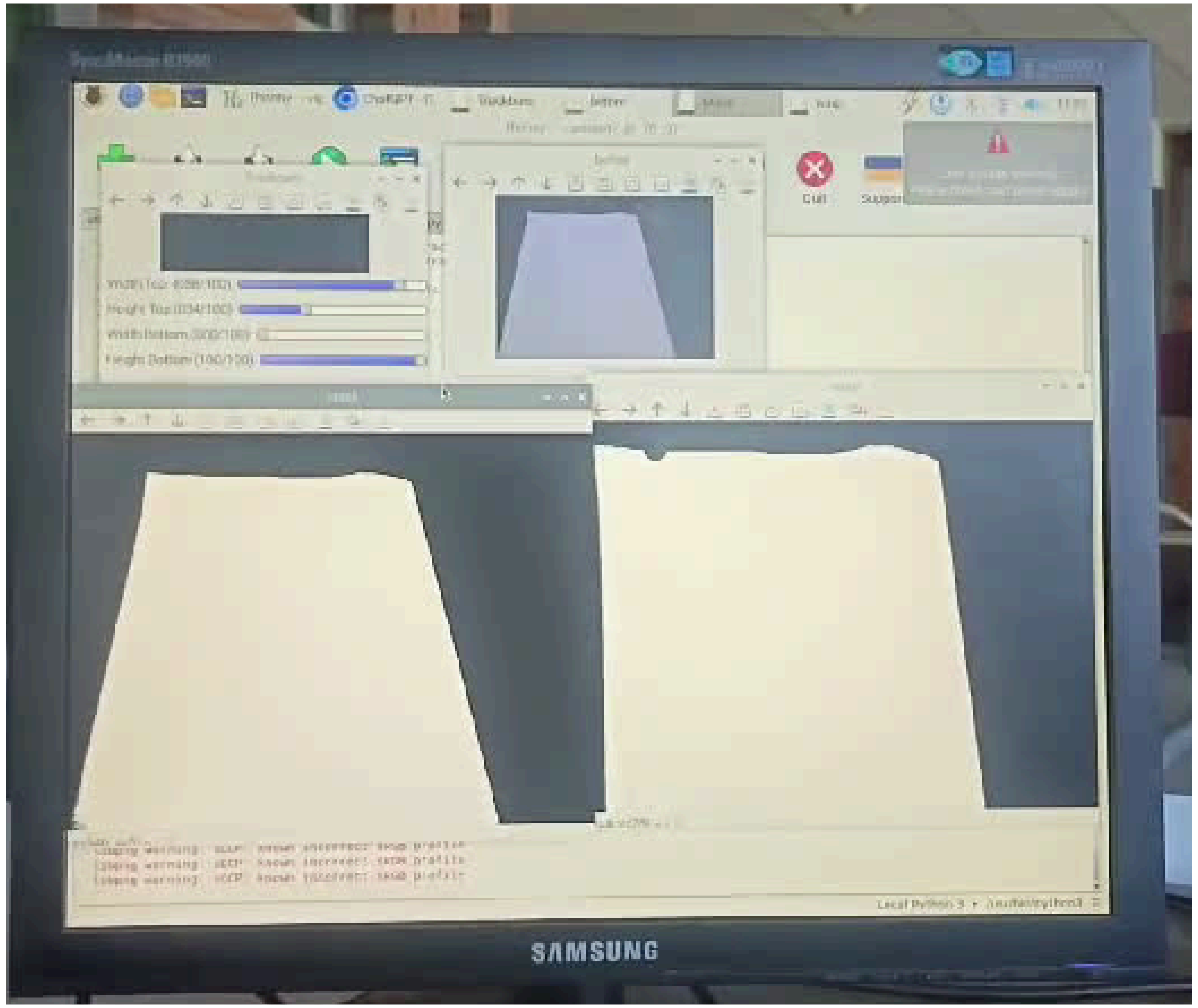
Warping

Warping in computer vision refers to mapping points to points without changing the colors



Example of the effect of the Warping transformation for the original image which is on the left (Binary Image) and the output on the right (Bird's Eye View Binary Image).

Warping



Example of real-time Warping and Thresholding

Pixel Summation

The pixel summation algorithm works on binary thresholded and warped images to identify the curvature of a lane or path

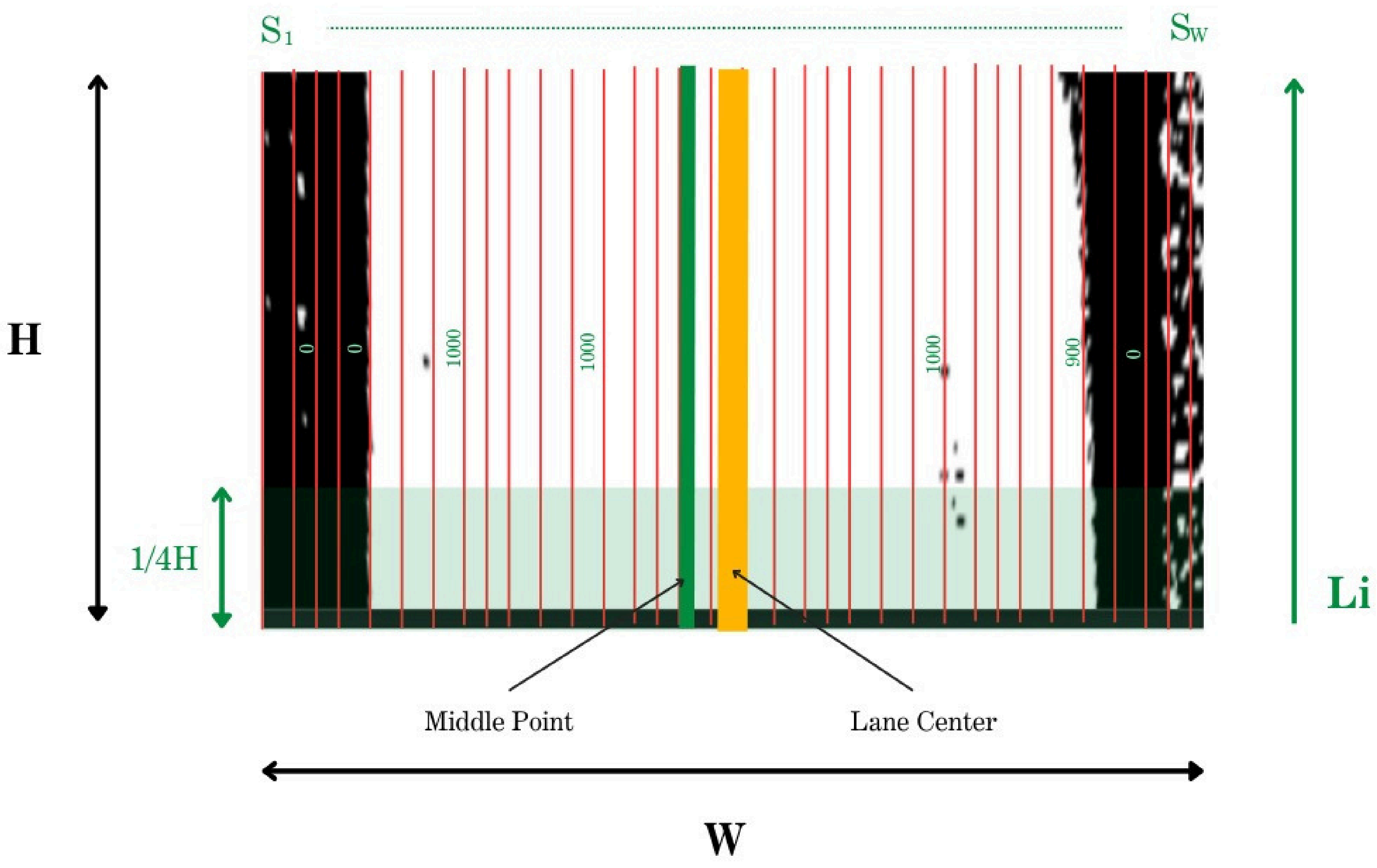
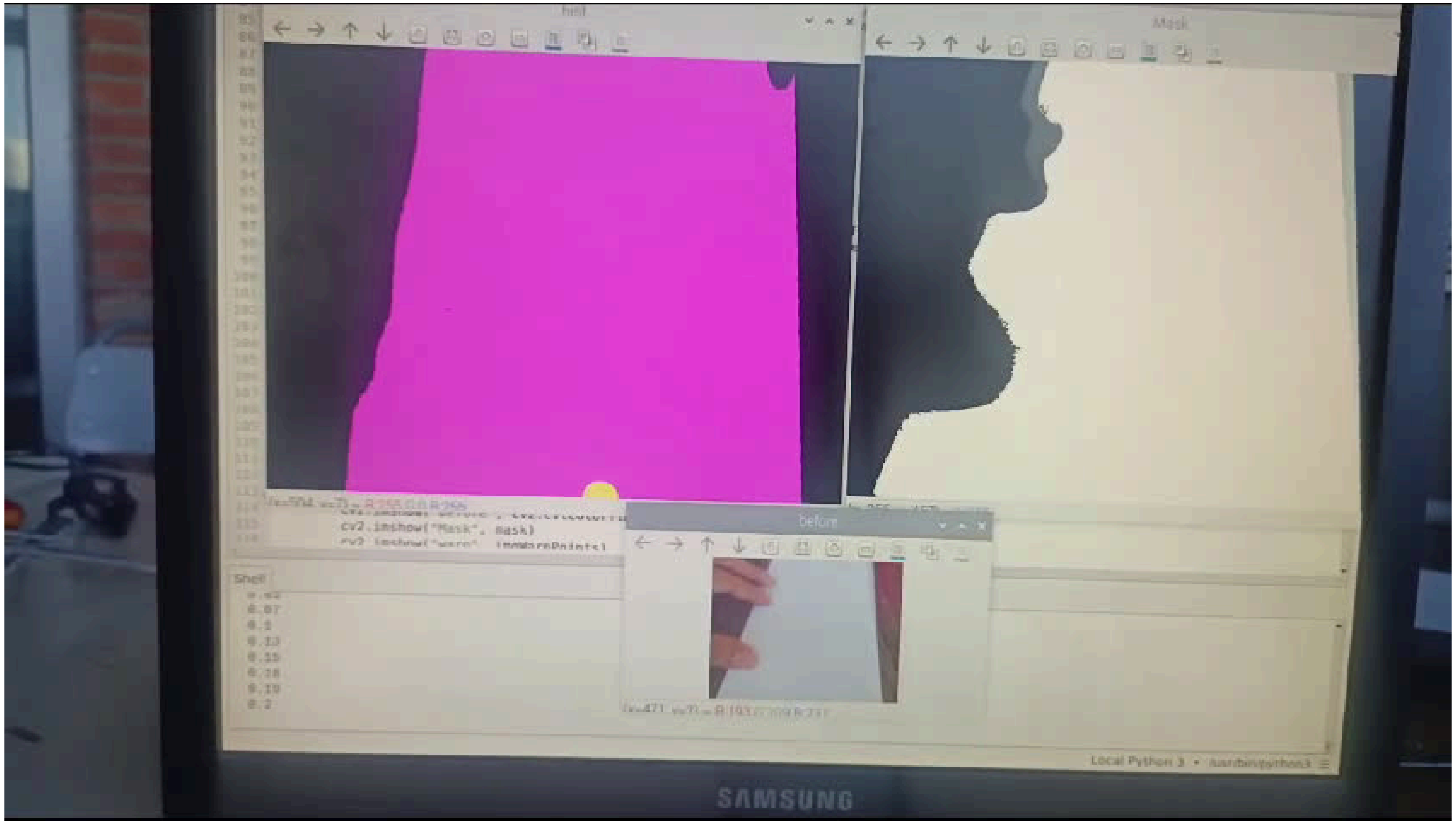


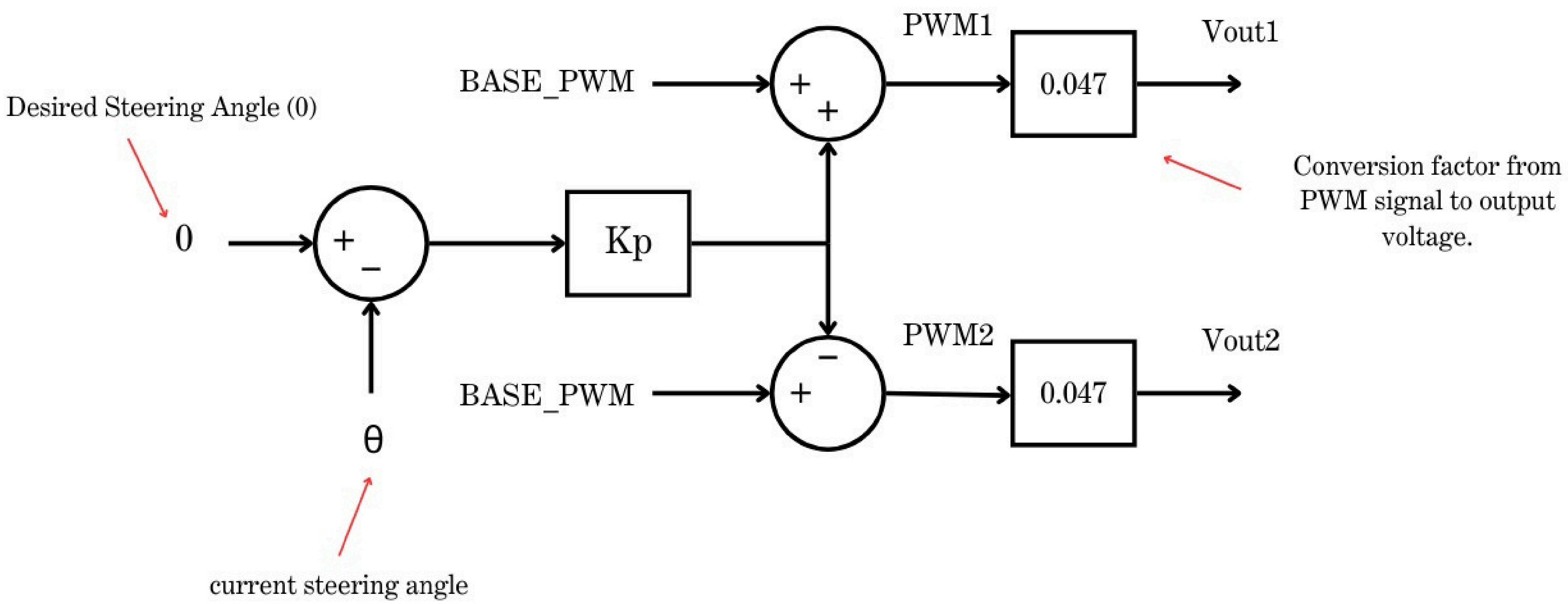
Illustration of the Pixel Summation Algorithm for calculating the Curve Value

Pixel Summation



Video 3 - Example of real-time
Thresholding, Warping and Pixel Summation

Steering Angle Calculation & Motors Control



Block diagram of the Motors Controller implemented in Arduino Uno.

The Problem of this method

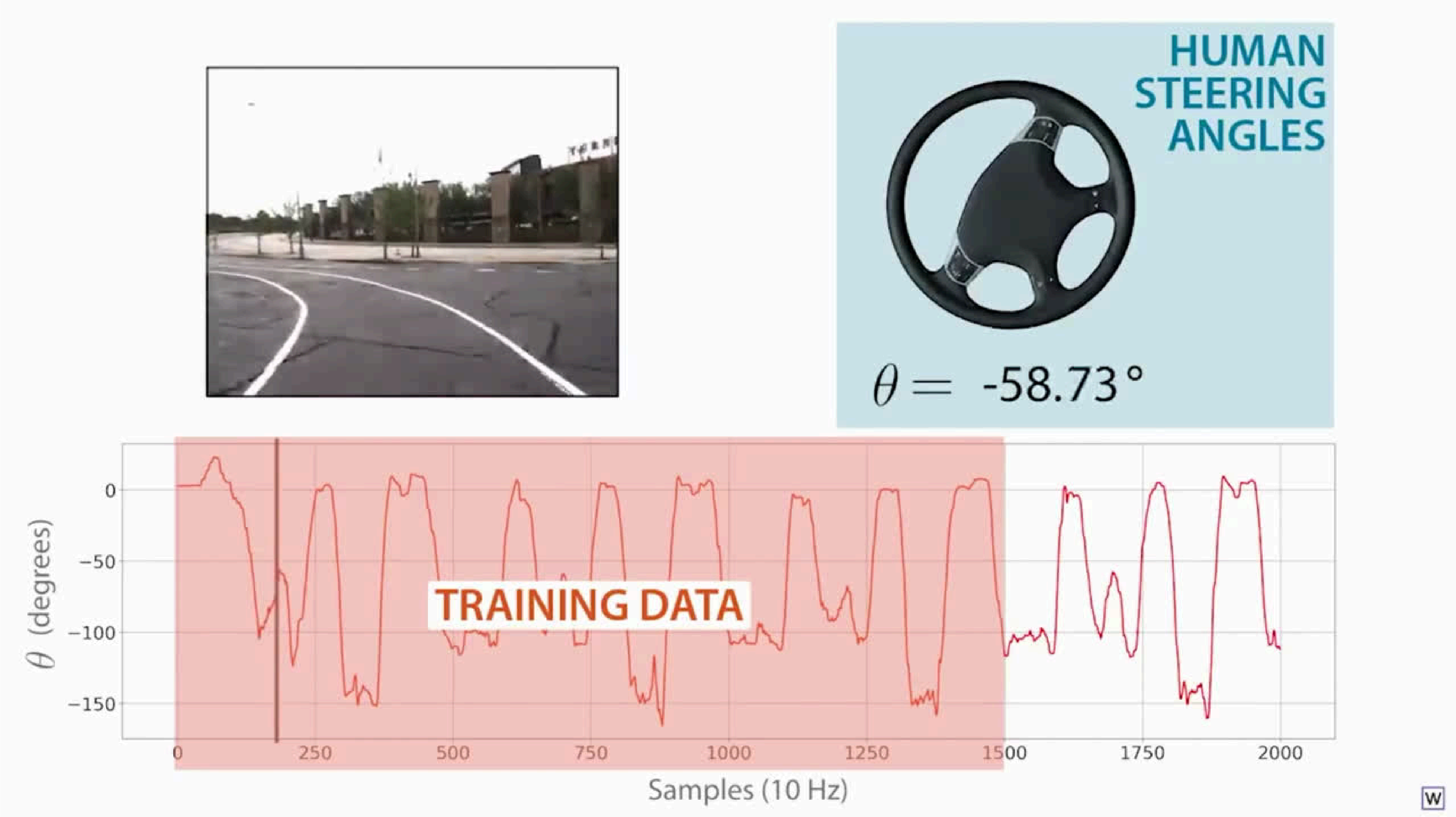
- ❌ The method needs lots of parameter adjusting.
- ❌ Sensible to tiny environment fluctuations, different light conditions, and shadows.
- ❌ Motor control algorithm depends only on the image algorithm output

Solution

✅ Using Deep Learning to associate different images in different environments with different steering angles.

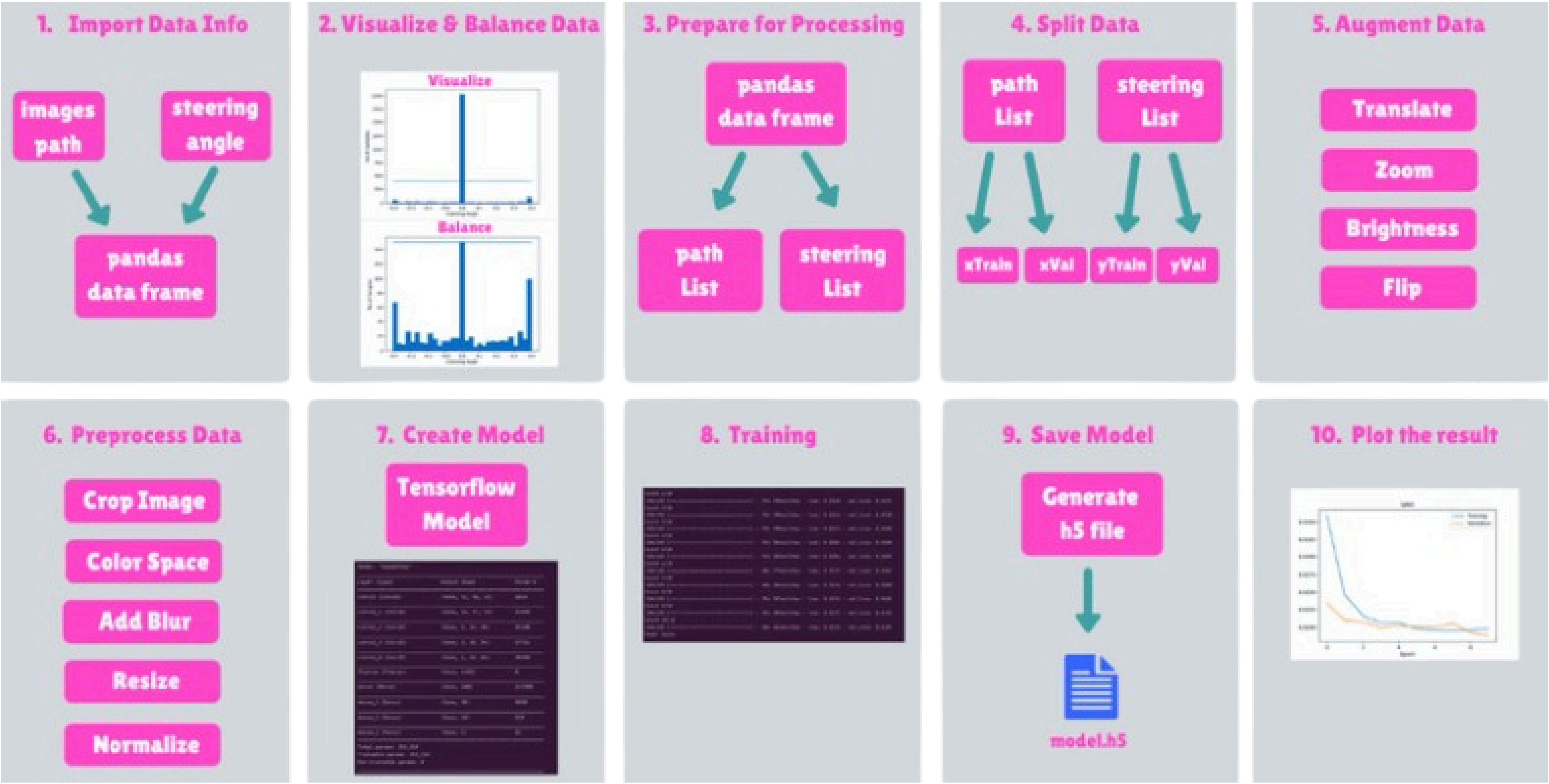
✅ Adding a software module that automates the parameter adjusting.

Deep Learning Integration



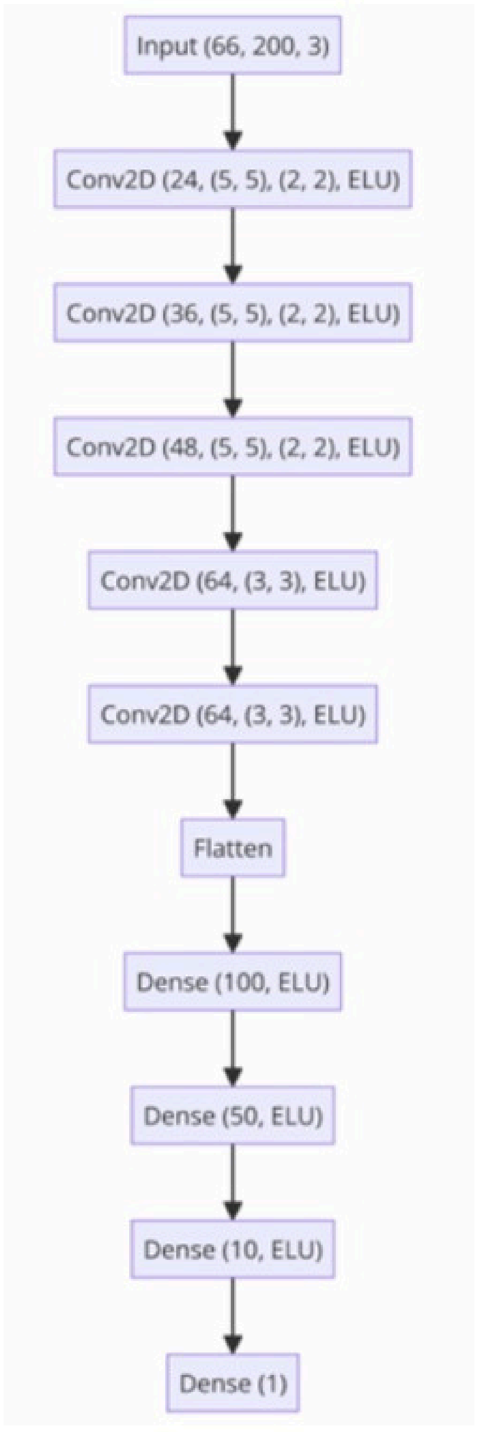
Example of the training phase of the Deep Learning Approach

Deep Learning Method Steps



Overview of the differents steps of our model

Model Software Architecture



Software Architecture of the model

Conclusion

Traditional computer vision techniques are not sufficient for reliable lane keeping systems

Deep Learning and more reliable approaches made lane-keeping systems overcome human driving capabilities and ensured more safety.

Deep learning projects are more complex in nature, it need multiple stages to be implemented successfully.

Motors should not be controlled directly via the input from the steering angle. To ensure safety, it is essential to incorporate additional inputs from various sensors.