Accurate, Low-Latency Visual Perception for Autonomous Racing: Challenges, Mechanisms, and Practical Solutions

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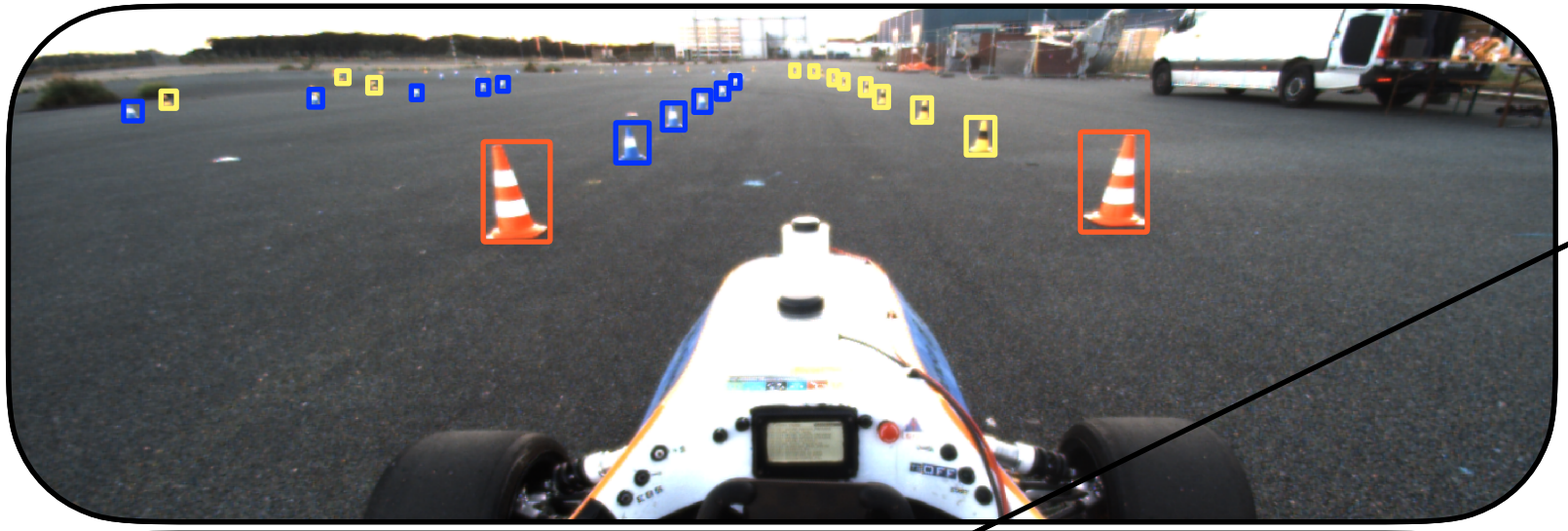
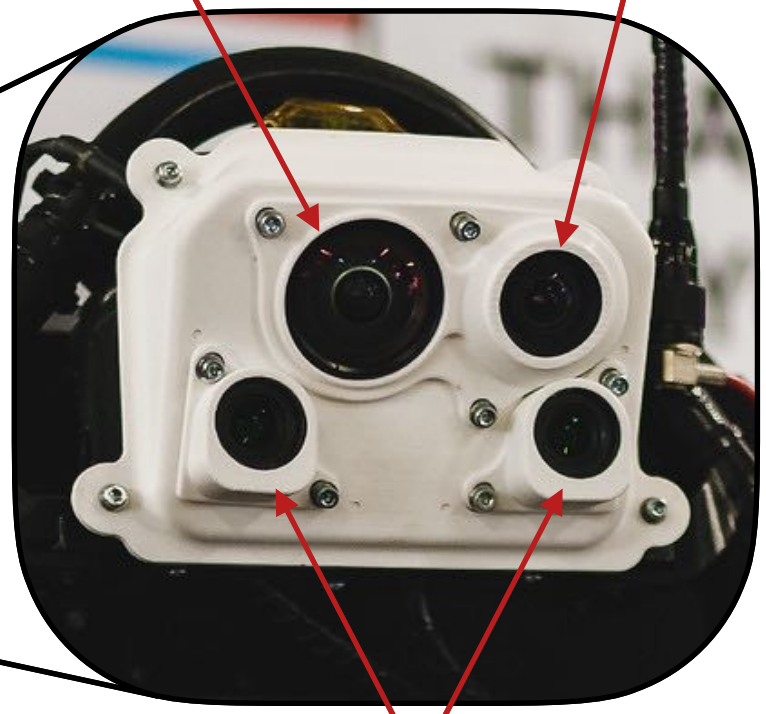
MIT

Introduction

Perception



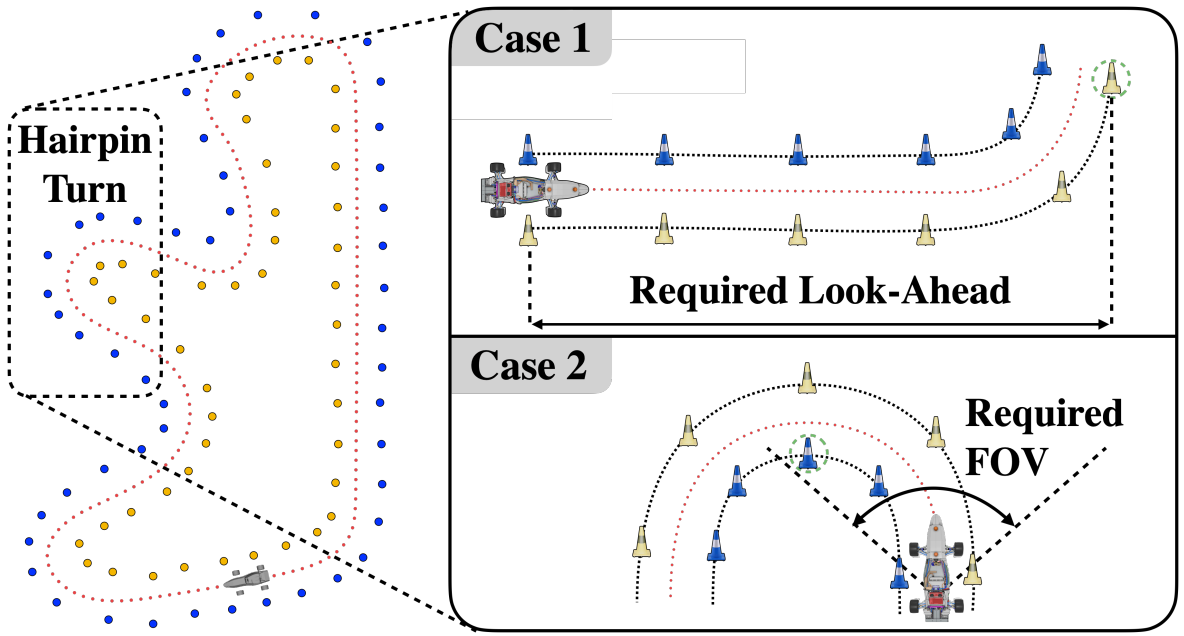


Wide Angle Camera

VIO Camera

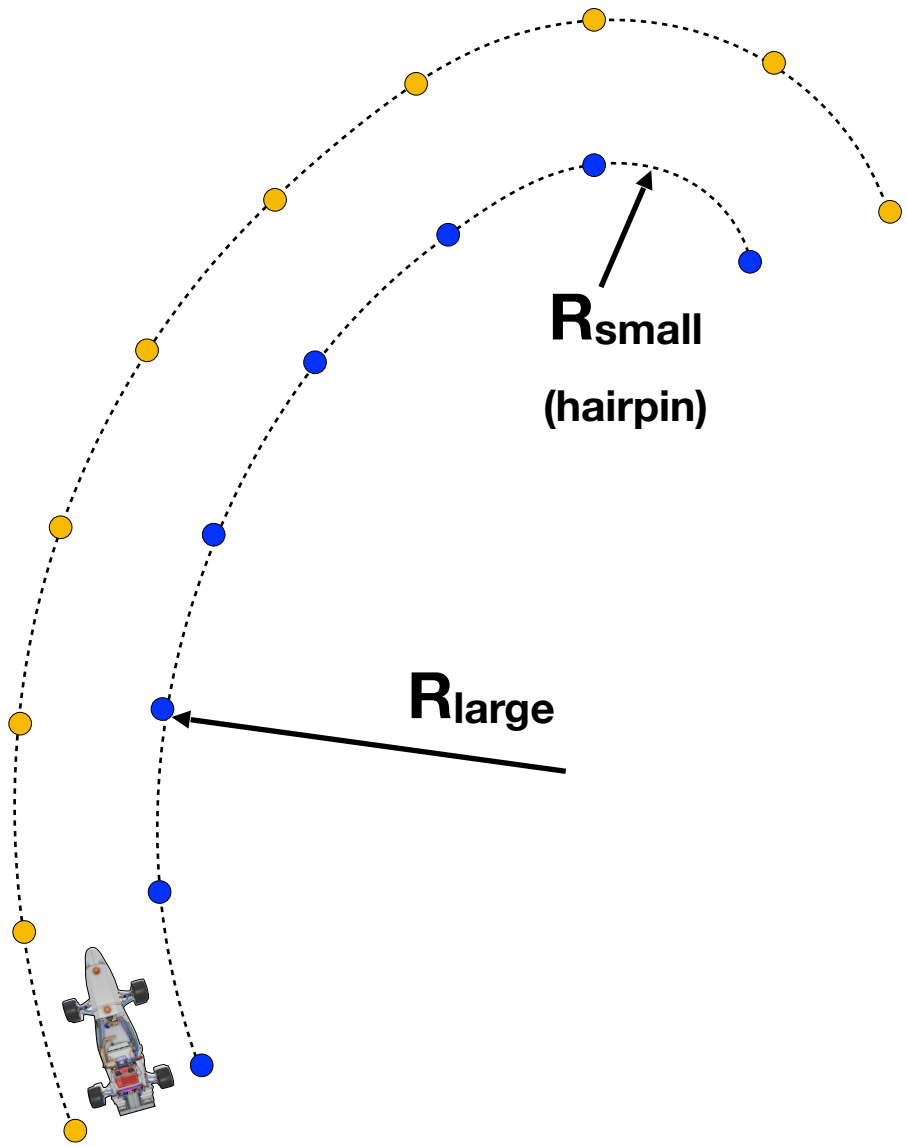
Stereovision Pair

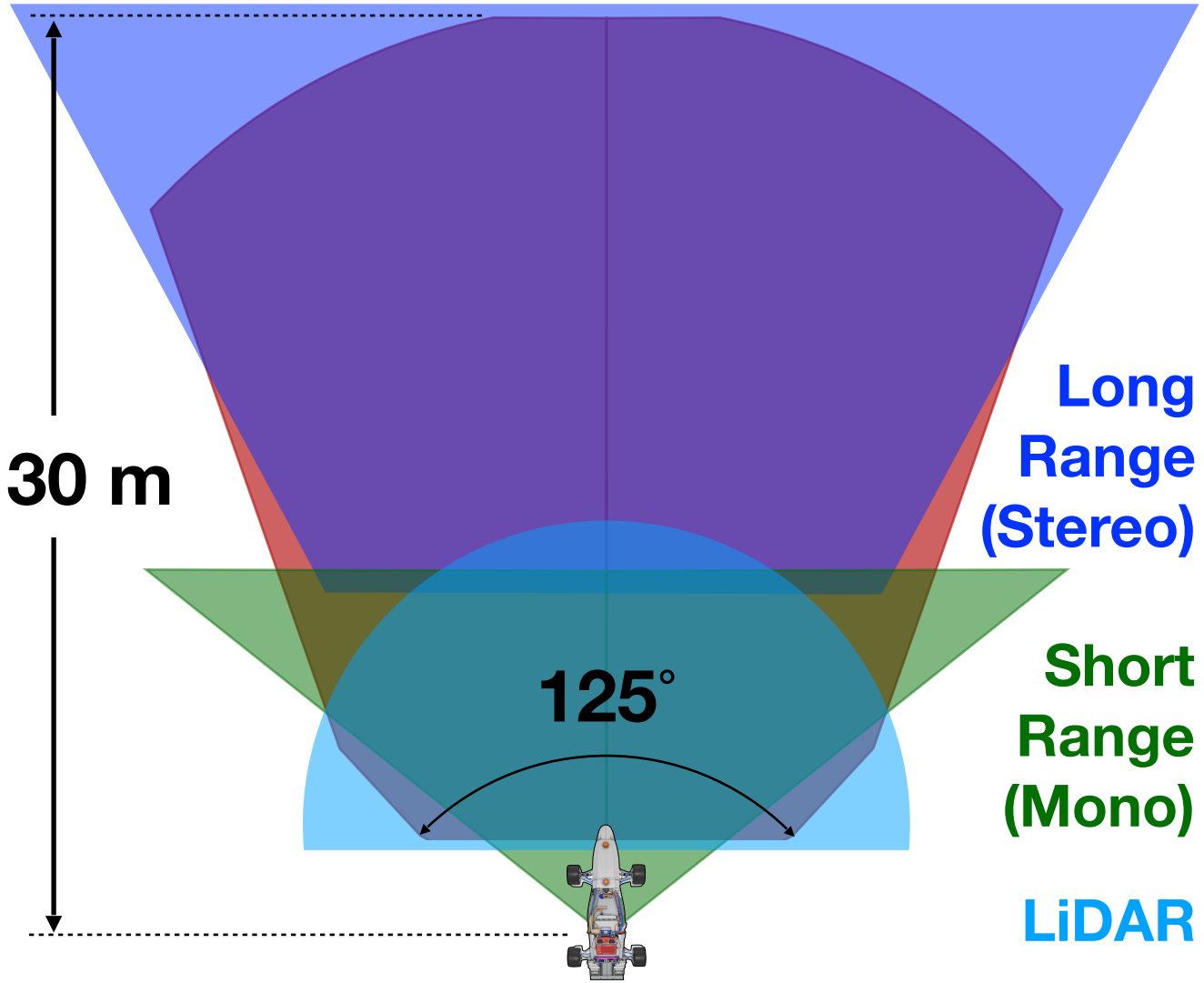
System Requirement



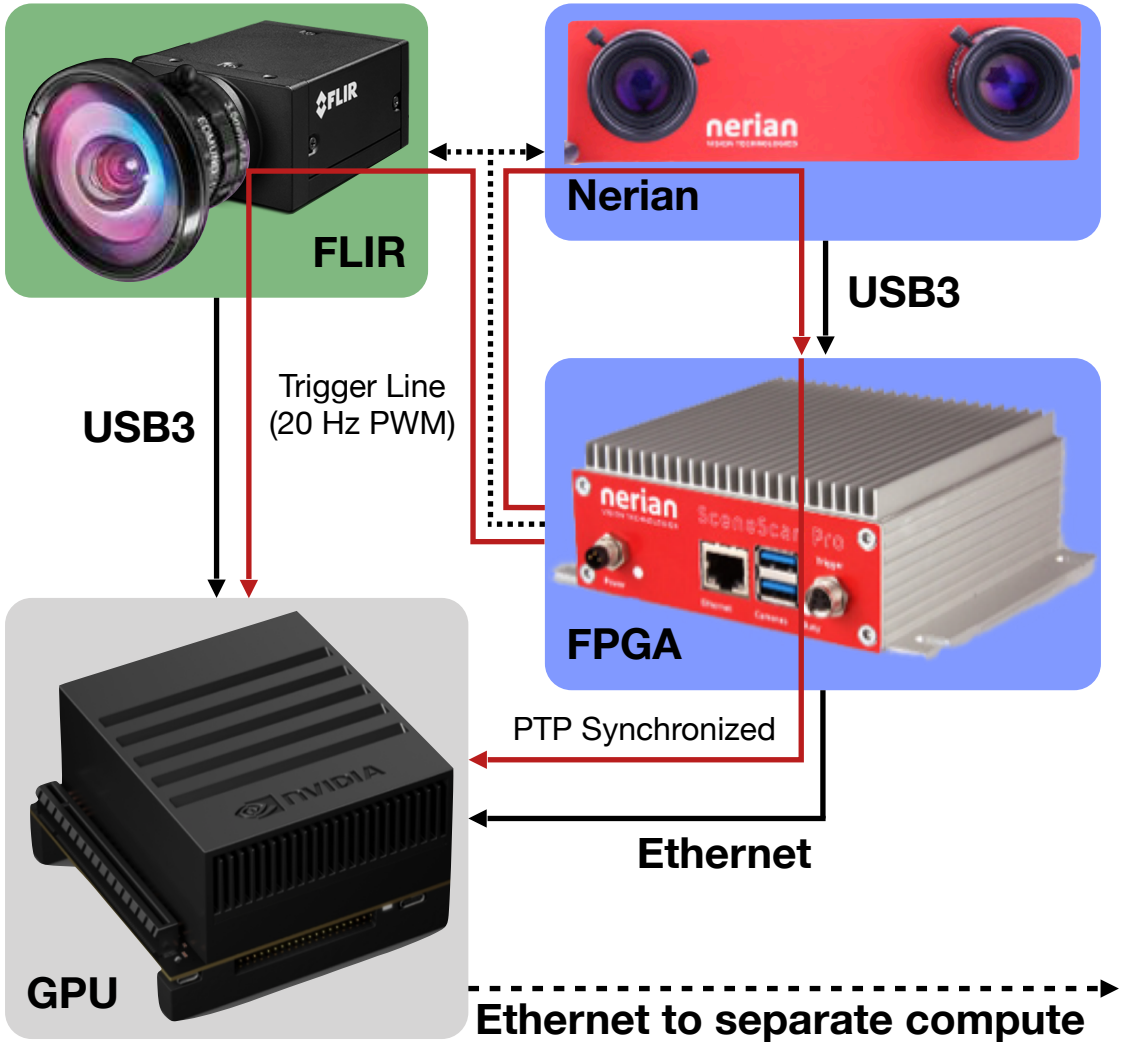
- *Latency*
  - Total time from a landmark coming into the perception system's view to the time it is localized.
- *Mapping Accuracy*
  - Max allowed landmark localization error.
- *Horizontal Field-of-View (FOV)*
  - The arc of visibility.
- *Look-ahead Distance*
  - Longest straight-line distance in which accuracy is maintained.

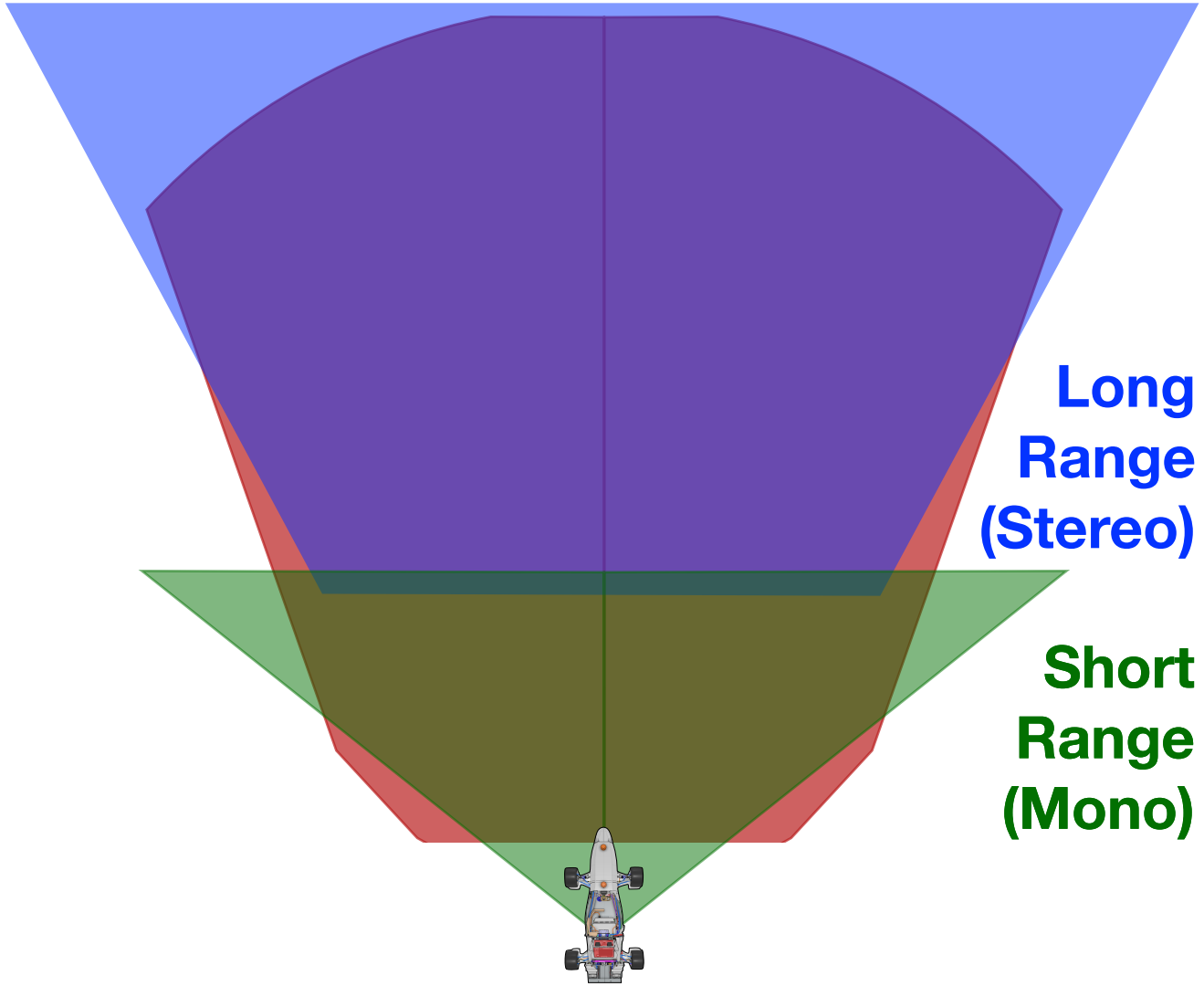
Viewing Region Requirements



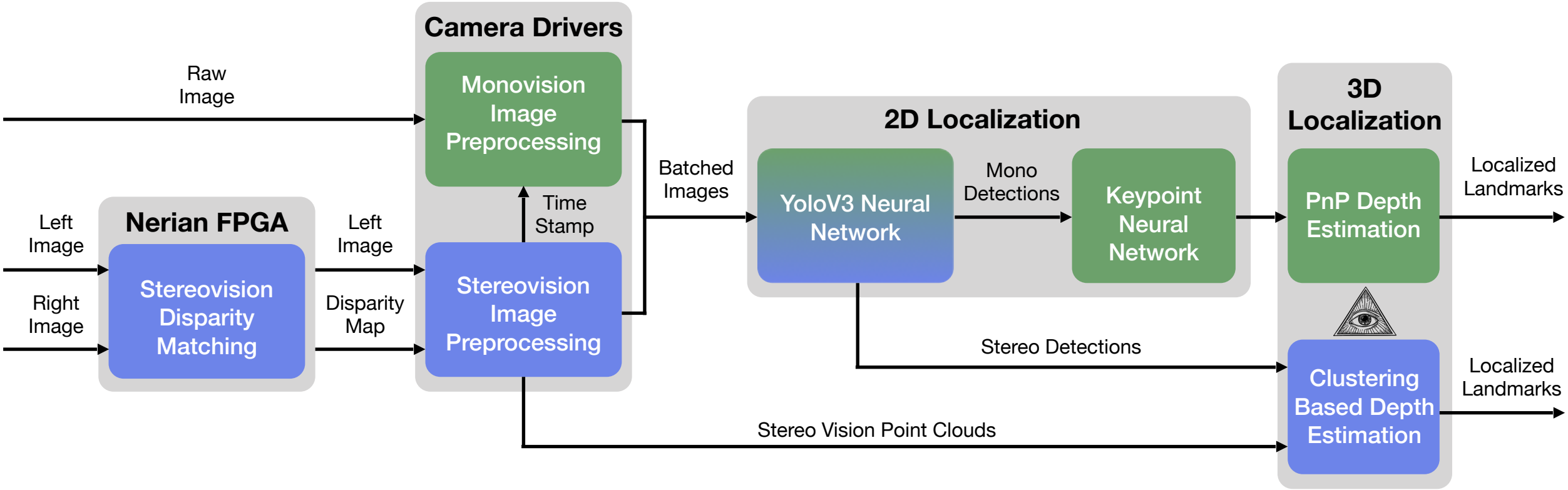


Camera Synchronization Hardware Selection





Perception Software Overview



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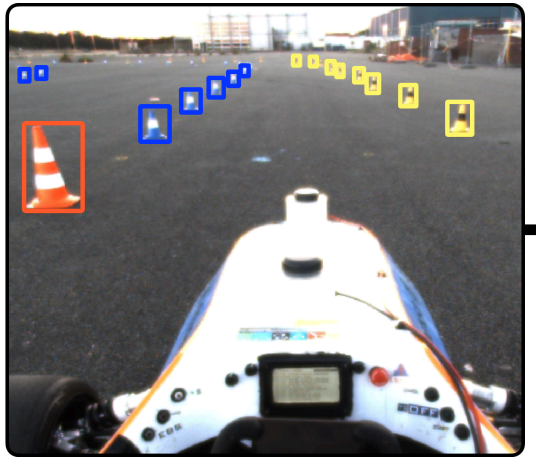
Depth Estimation

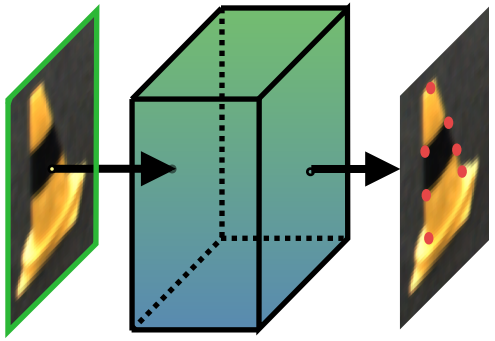
Step 1



Object Detection

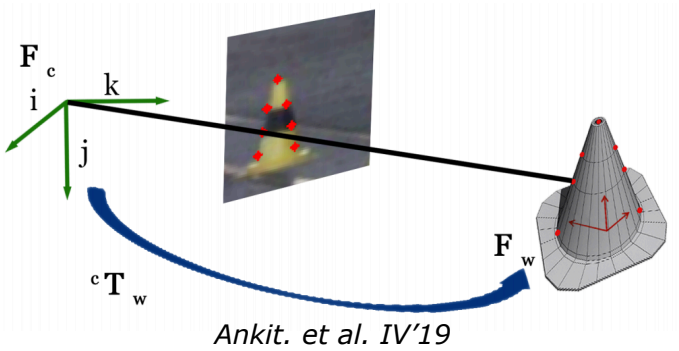
Mono

Step2



Keypoints Detection

Step3



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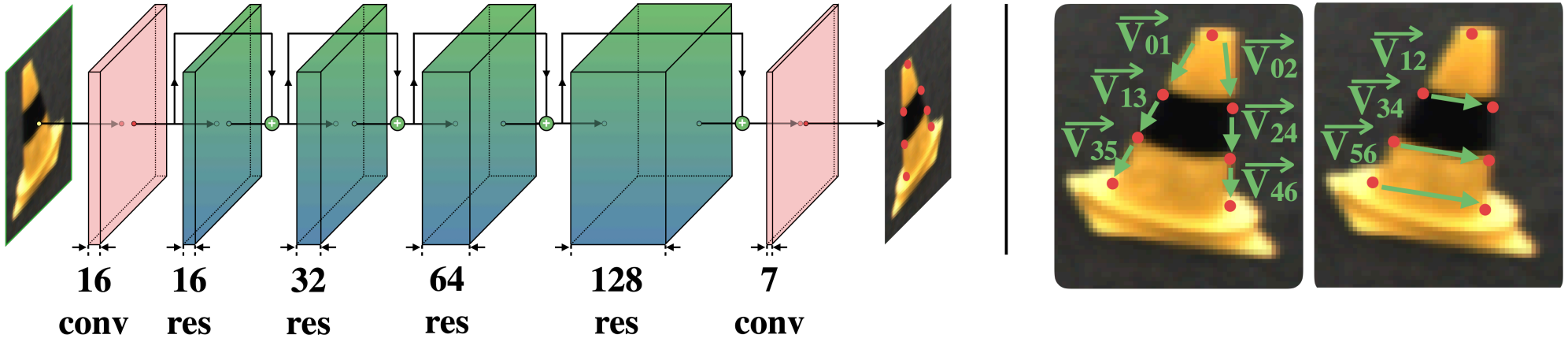
Perspective-n-Point (PnP)

Stereo

Step2

Stereo Matching Algorithm

Software Design - Keypoints Detection



- Detects seven keypoints on each YOLOv3 detection
- A residual NN that leverages the geometric relationship between keypoints
- Seven detected key points will be then used in a Perspective-n-Point (PnP) to get depth

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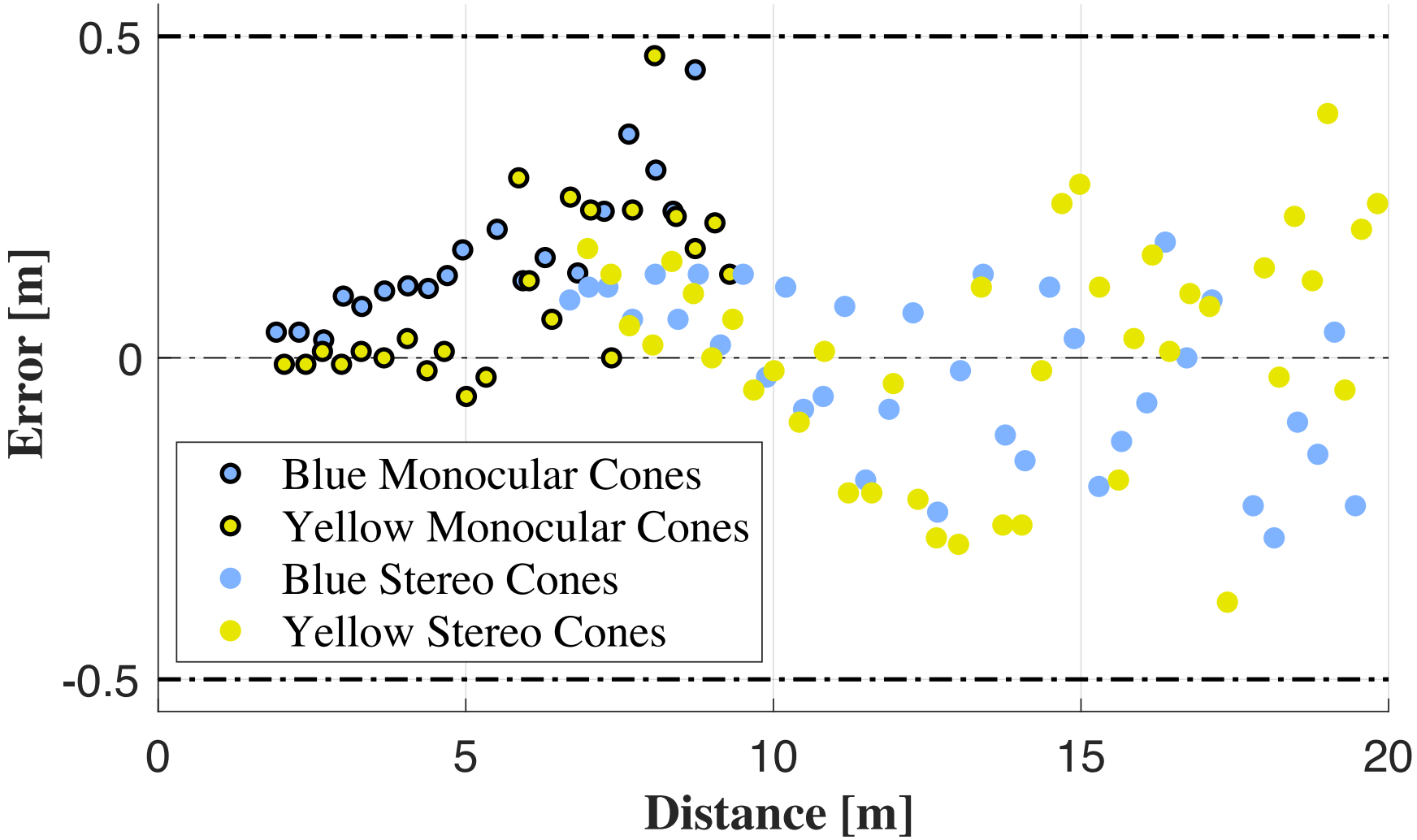
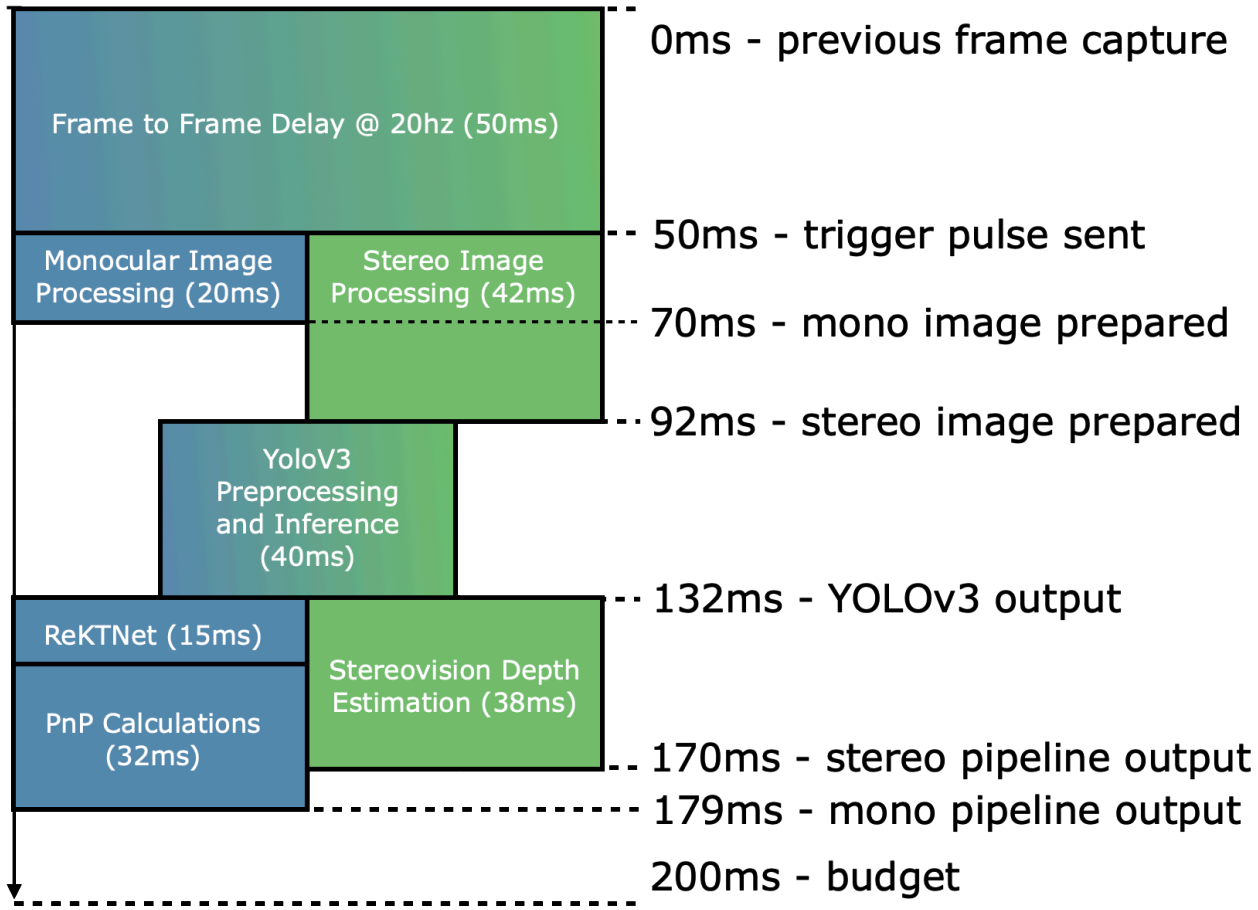
Validation - Accuracy



Validation - Latency



Open Sourced here: github.com/cv-core

Thank you for your attention