PREPARE FOR WARP SPEED

SUB-MILLISECOND VISUAL PLACE RECOGNITION USING EVENT CAMERAS

Vignesh Ramanathan, Michael Milford and Tobias Fischer
Queensland University of Technology

Centre for Robotics

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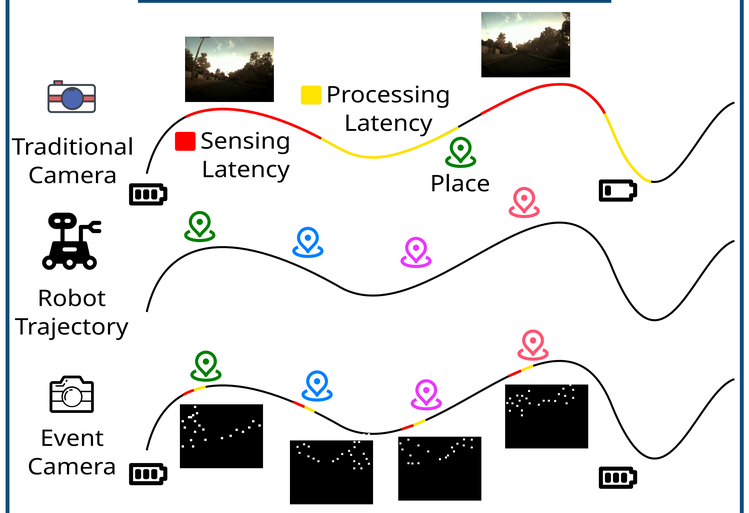
OVERVIEW

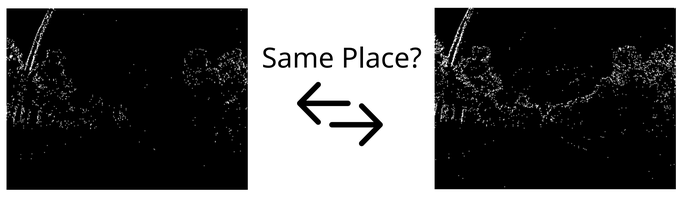
1. Visual Place Recognition (VPR) is the ability to recognize previously seen places in the world based solely on images
2. Flash is a **low-latency** VPR system that turns sparse event-camera data into fast place matches, using **binary** representations and **sparse** computation for **high-speed robotics**

WHY USE EVENT CAMERAS?



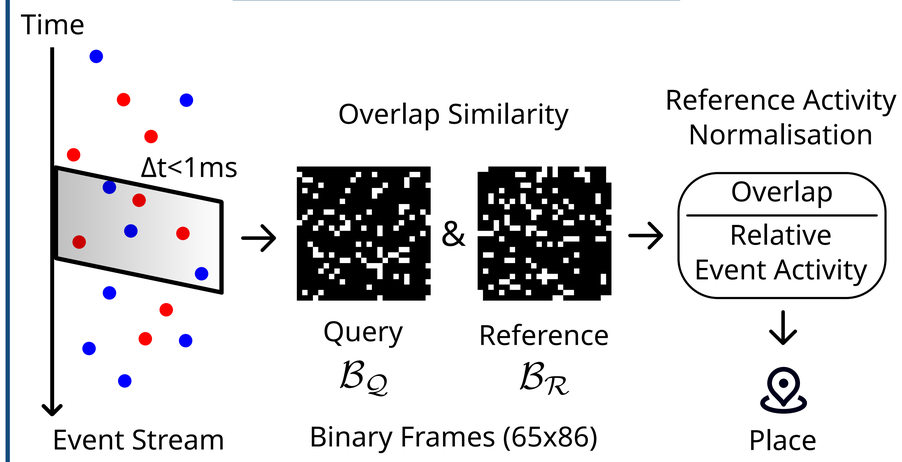
1. Traditional camera are limited by bandwidth-latency tradeoffs
2. Event cameras offer microsecond temporal resolution and provide sparse output

KEY INSIGHT



1. Place identity is encoded in where event occur
2. *Sub-millisecond* slices contain rich spatial information for VPR

HOW DOES FLASH WORK?



Active Pixels

$$\Omega_\mathcal{B} = \{(x, y) \mid \mathcal{B}(x, y) = 1\}$$

Overlap Similarity

$$S(\mathcal{B}_\mathcal{Q}, \mathcal{B}_\mathcal{R}) = \sum_{(x,y)\in\Omega_{\mathcal{B}_\mathcal{Q}}} \left(\mathcal{B}_\mathcal{Q}(x, y)\ \&\ \mathcal{B}_\mathcal{R}(x, y)\right)$$

Reference Activity Compensation (RAC)

$$\tilde{w}(\mathcal{B}_\mathcal{Q}, \mathcal{B}_\mathcal{R}) = \min\left(\frac{|\Omega_{\mathcal{B}_\mathcal{Q}}|}{|\Omega_{\mathcal{B}_\mathcal{R}}|}, 1\right)$$

WHY *FLASH* IS FAST?

Sub-millisecond Event Slice

Sensing Latency (<1ms)

01100
10110
11110
Binary Representation

Sparse Computing

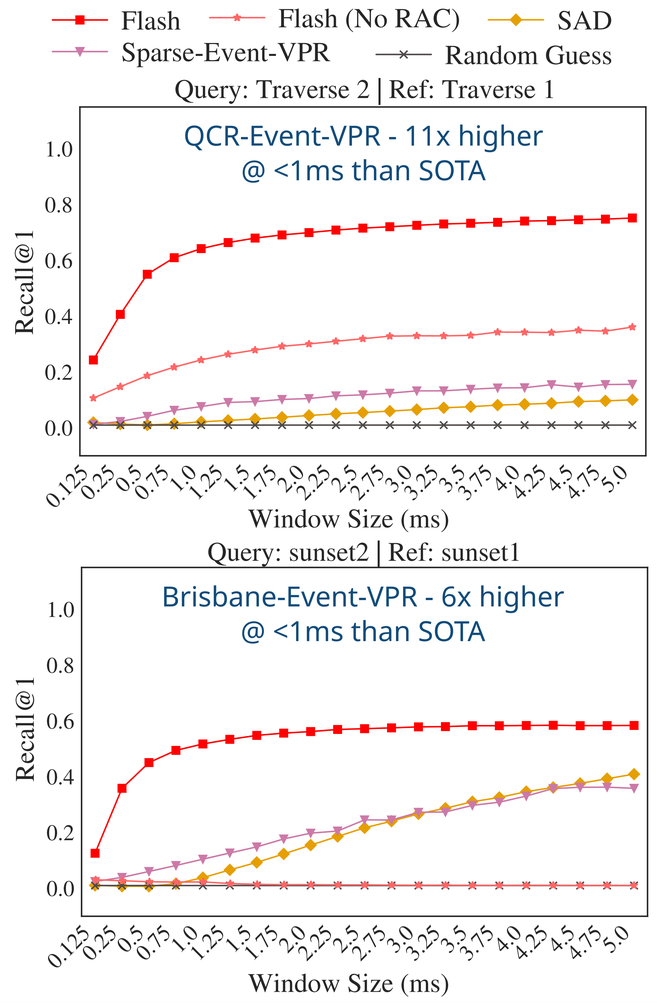
Lightweight Operations

Processing Latency

REFERENCES

1. Schubert et al., “Visual place recognition: A tutorial,” RAM '23
2. Gallego et al. "Event-based vision: A survey.", TPAMI '20
3. Fischer et al., "How Many Events Do You Need? Event-Based Visual Place Recognition Using Sparse But Varying Pixels", RAL '22

HOW ACCURATE IS FLASH?



DOES FLASH REDUCE POSITION BLIND TIME?