Density Invariant Contrast Maximization for Neuromorphic Earth Observations UNE 18-22, 2023 UNITED STATES **AIR FORCE** Sami Arja, Alexandre Marcireau, Richard L. Balthazor, Matthew G. McHarg, Saeed Afshar, Gregory Cohen ACADEMY

Introduction

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- Project Falcon Neuro was a collaboration between WSU and USAFA that placed an event camera on the ISS for earth imaging, representing the first of its kind in such an environment
- Data from the ISS are extremely dense and noisy
- To enable Neuromorphic Earth Observations we propose an analytical solution to the contrast maximization (CMax) algorithm to handle highly dense scenes

Problem

CMax is noise-intolerant: multiple extrema appear on the loss surface



Question How to make CMax

invariant to high event densitv?

High variance does not always indicate a high level of contrast The optimizer is likely to converge to an incorrect solution



Method



Analytical Piecewise Correction Functions

Correct the warped image with a multiplicative weight function to analytically cancel the noise-induced variance



Loss surface with the noise-induced variance

CMax aims at estimating the camera's motion parameters by aligning the events to a candidate point trajectories that give the maximum image contrast. Gallego et al. CVPR'18

Assumptions:

- Constant-speed linear motion
- Time window can be arbitrary large
- No prior about events rate

Contribution: Making CMax invariant to the density of events, analytically



Results











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	CMax [8]		Ours	
	RMS	RoC%	RMS	RoC%
alvador	14.47	2.55	0.61	75.57
ston	13.74	2.62	0.55	81.48
any	0.08	83.13	0.01	83.57
ico	14.13	1.16	0.09	80.50
nington	14.19	2.87	0.11	74.10
1	13.77	2.45	0.14	80.82
atra	13.41	1.62	0.22	81.60
	12.84	2.02	0.28	82.89
ot	13.53	1.95	0.01	76.51
ma	14.50	2.72	0.04	70.61

Neuromorphic Earth Observations



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