Sim2Real-Fire: A Multi-modal Simulation Dataset for Forecast and Backtracking of Real-world Forest Fire

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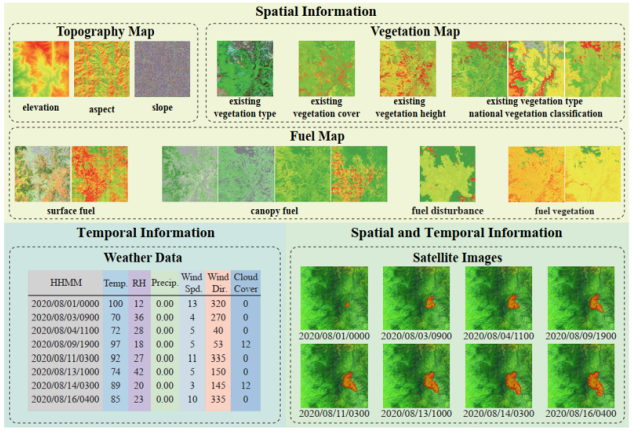
Introduction

The latest research on wildfire forecast and backtracking has adopted AI models, which require a large amount of data from wildfire scenarios to capture fire spread patterns. We explore using cost-effective simulated wildfire scenarios to train AI models and apply them to the analysis of real-world wildfire. This solution requires AI models to minimize the Sim2Real gap, a brand-new topic in the fire spread analysis research community.

To investigate the possibility of minimizing the Sim2Real gap, we collect the **Sim2Real-Fire dataset** that contains 1M simulated scenarios with multi-modal environmental information for training AI models. We prepare 1K real-world wildfire scenarios for testing the AI models. We also propose **a deep transformer, S2R-FireTr,** which excels in considering the multimodal environmental information for forecasting and backtracking the wildfire. S2R-FireTr surpasses state-of-the-art methods in real-world wildfire scenarios.

Sim2Real-Fire dataset

The Sim2Real-Fire dataset contains wildfire simulation and real-world data. The set includes 1M and 1K wildfire scenarios.



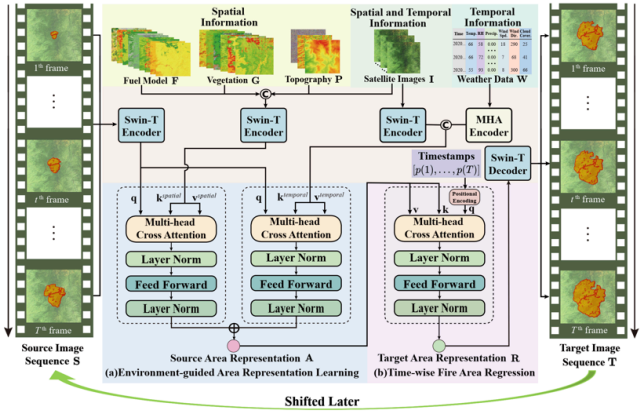
HHMM	Temp.	RH	Precip.	Wind Spd.	Wind Dir.	Cloud Cover
2020/08/01/0000	100	12	0.00	13	320	0
2020/08/03/0900	70	36	0.00	4	270	0
2020/08/04/1100	72	28	0.00	5	40	0
2020/08/09/1900	97	18	0.00	5	53	12
2020/08/11/0300	92	27	0.00	11	335	0
2020/08/13/1000	74	42	0.00	5	150	0
2020/08/14/0300	89	20	0.00	3	145	12
2020/08/16/0400	85	23	0.00	10	335	0

Topography, vegetation, fuel, weather, and the satellite data in the Sim2Real-Fire dataset.

Name	Scenarios	Countries	Areas	Tasks	Period	Spatial Resolution	Temporal Resolution	Sim/Real	Modalities
GABAM	10K	Worldwide	149,000,000	Fire Behavior	1990-2021	30m	1year	Real Only	1
Fire Atlas	13M	Worldwide	149,000,000	Fire Behavior	2003-2016	500m	1day	Real Only	1
GlobFire	100M	Worldwide	149,000,000	Fire Behavior	2001-2017	500m	1day	Real Only	1
WildfireDB	17M	USA	9,834,000	Spread Forecast	2012-2017	375m	1day	Real Only	4
SeasFire Cube	20K	Worldwide	149,000,000	Burned Area Forecast	2001-2021	27km	8days	Real Only	4
Next Day Wildfire	18K	USA	9,834,000	Spread Forecast	2012-2020	1km	1day	Real Only	4
WildfireSpreadTS	607	USA	9,834,000	Spread Forecast Spread Backtrack	2018-2021	375m	1day	Real Only	4
PT-FireSprd	80	Portugal	92,150	Fire Behavior Spread Forecast Danger Forecast Burned Area Forecast	2015-2021	1m-4km	30mins-14hours30mins	Real Only	1
Mesogeos	25K	Mediterranean	9,000,000	Danger Forecast Burned Area Forecast	2006-2022	1km	1day	Real Only	4
MODIS Thermal Anomaly	40K	Worldwide	149,000,000	Danger Forecast Spread Forecast	2000-2024	1km	1day	Real Only	3
VIIRS Thermal Anomaly	40K	Worldwide	149,000,000	Danger Forecast Spread Forecast	2012-2024	375m	12hours	Real Only	3
NOAA HMS Fire	1K	North America	24,710,000	Danger Forecast	2003-2024	2km	1day	Real Only	3
NOAA HMS Smoke	1K	North America	24,710,000	Danger Forecast	2005-2024	2km	1day	Real Only	1
GOES Wildfire	1K	Western Hemisphere	61,000,000	Danger Forecast Spread Forecast Burned Area Forecast	2017-2024	2km	5mins	Real Only	4
NIFC Wildfire Perimeters	20K	USA	9,834,000	Spread Forecast Burned Area Forecast	2000-2024	2km	5mins	Real Only	1
Sim2Real-Fire	**1M**	**Worldwide**	**20,000,000**	**Spread Forecast Spread Backtrack**	**2013-2023**	**30m**	**1hour**	**Sim&Real**	**5**

Comparison with the related datasets for wildfire analysis.

S2R-FireTr



S2R-FireTr predicts future wildfire areas from source fire areas. (a) Source fire areas and environmental data are input into the transformer to compute source area representation A. (b) A and the target timestamp are used to compute target area representation R for future predictions. Interchanging source and target areas allows wildfire backtracking.

Acknowledgement

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