Artificial Intelligence-Aided Railroad Trespassing Data Analytics: Methodology and A Case Study

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Abstract

Using video data and artificial intelligence, real time detection of railroad trespassing can be obtained. Of all the rail-related fatalities, trespassing is one of the top causes and little progress has been done to stop the prevention of such accidents. While there are many surveillance cameras to witness such accidents, the cost of employing people to continuously monitor the video still introduces drawbacks. However, using the real time video from the cameras and computer vision, algorithms can take the role of detecting trespassing at the railways, eliminating the need of human monitoring.

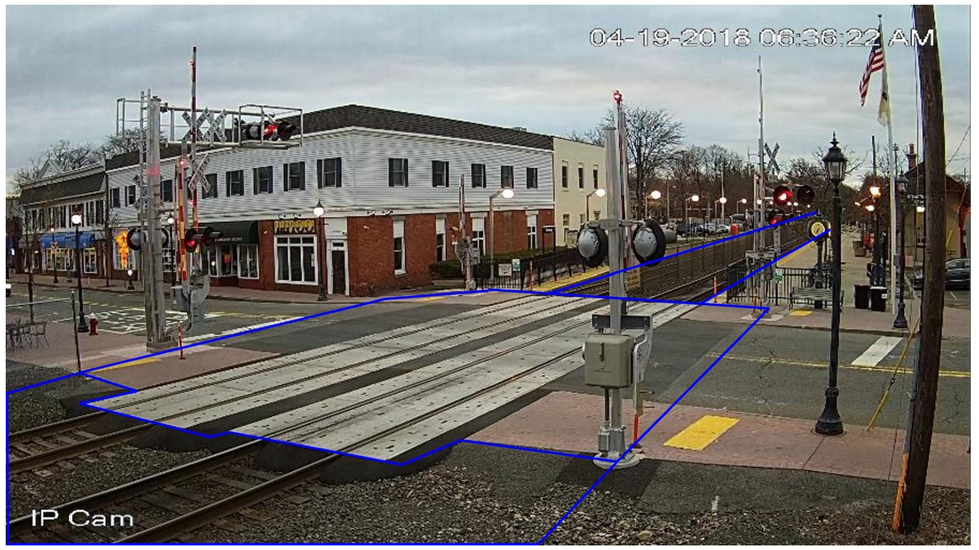
A computer vision algorithm, You-Only-Look-Once (YOLO), that can detect objects in real time, is used to create a framework that the railroad industry can use to change the infrastructure of the locations where trespassing occurs in order to safeguard from accidents. From that data generated from this framework, data such as: the time of day, weather, type of trespassing, and location on railway of trespassing can be outputted on detection and stored in a database for easy processing.

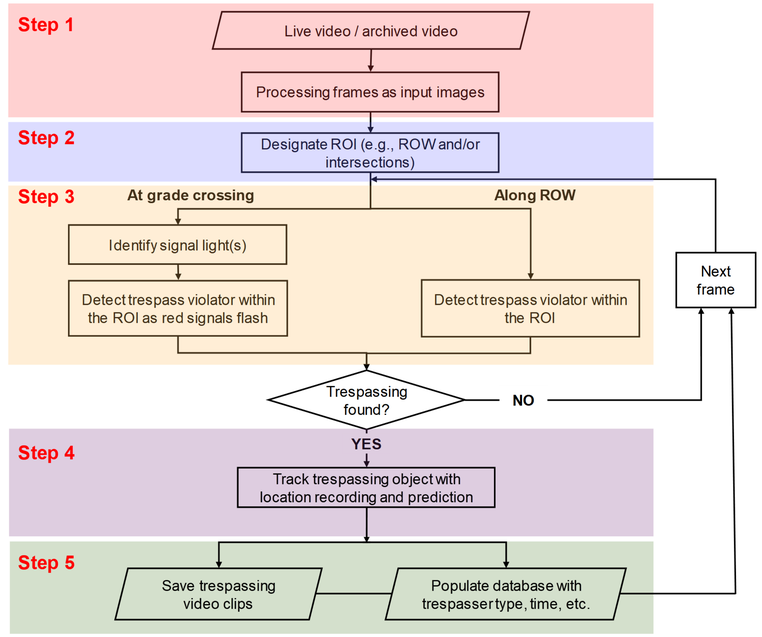
Background

You Only Look Once (YOLO) is a state-of-the-art deep learning-based detection method in terms of processing speed and accuracy. This makes YOLO more suited to this task as it requires live video analysis. YOLO is trained with the Common Objects in Context (COCO) dataset which contains 80 classes of objects, 6 of those objects are focused on in this research: 'person', 'bicycle', 'car', 'motorbike', 'bus', and 'truck'.

The case study for this research is a railroad crossing located in Ramsey, New Jersey. The times captured are: April 19-25, 2018 (7 days), September 2018 (30 days), and January 2019 (31 days).

Methods and Materials





Results

Day/Time	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	Sum
Monday	2	1	2	0	0	1	1	3	16	9	15	8	24	25	37	7	16	11	9	3	6	2	9	3	207
Tuesday	1	1	0	0	0	5	8	30	22	14	26	25	34	30	31	52	42	47	19	22	28	9	5	6	454
Wednesday	3	7	1	0	2	1	11	25	30	18	31	17	31	30	31	43	36	55	35	18	24	14	9	7	475
Thursday	5	5	0	0	2	5	15	28	26	19	18	23	19	31	27	44	34	74	48	20	23	18	10	10	501
Friday	1	6	1	0	1	0	19	31	25	23	23	24	20	31	19	40	16	63	35	22	26	9	0	11	442
Saturday	3	12	6	2	2	1	9	32	42	26	19	33	37	36	22	55	53	100	49	51	19	10	6	5	628
Sunday	3	2	1	0	0	0	2	10	22	10	32	12	27	19	47	7	31	10	28	5	10	1	11	9	296
Sum	18	34	11	2	7	13	64	157	182	118	162	140	190	199	212	250	227	361	222	140	134	62	49	50	3004

Figure 1. Trespassing Events, grouped by day of the week and time of day

From that video data analysis, data such as time of day and day of the week can be pulled from the algorithm. This is very helpful in determining characteristics of trespassing and time/location of trespassing which can be used in preventing future trespassing events. Examples of such prevention strategies include police being on duty during peak hours and giving students who ride school buses and commuters from Ramsey Station more education on safety issues.

Future Direction

The future direction for this research is to conduct more case studies on different locations in order to gather more data on what situations do trespassing occurs.

Afterwards, there are ideas on expanding the algorithm for detecting other objects that might appear on the railways such as livestock or obstacles.

Other ideas include using video data from a camera that is located on the front of a locomotive as well. The challenge for this task would be dynamically defining the Region of Interest, but the advantage would be highly efficient detection of trespassing along the right-of-way.

References

[1] Zaman, A., Ren, B. and Liu, X., 2019. Artificial Intelligence-Aided Automated Detection of Railroad Trespassing. Transportation Research Record, p.0361198119846468.
[2] Zhang, Z., Trivedi, C. and Liu, X., 2018b. Automated detection of grade-crossing-trespassing near misses based on computer vision analysis of surveillance video data. Safety Science, 110, pp.276-285.
[3] Redmon, J., Divvala, S., Girshick, R. and Farhadi, A., 2016. You only look once: Unified, real-time object detection. In Proceedings of the IEEE conference on computer vision and pattern recognition (pp. 779-788).
[4] Redmon, J. and Farhadi, A., 2018. Yolov3: An incremental improvement. arXiv preprint arXiv:1804.02767.
[5] Zhang, Z., Xu, J. Liu, X., Zaman A., 2020. Artificial Intelligence-Aided Railroad Trespassing Detection and Data Analytics: Methodology and A Case Study. Working Paper.

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