Automated traffic congestion estimation via public video feeds

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Problem definition

- Traffic congestion is an ever-growing problem.
- Current traffic monitoring systems require time and money to deploy.
- Alternatives that use crowd-sourcing depend on the number of active users.

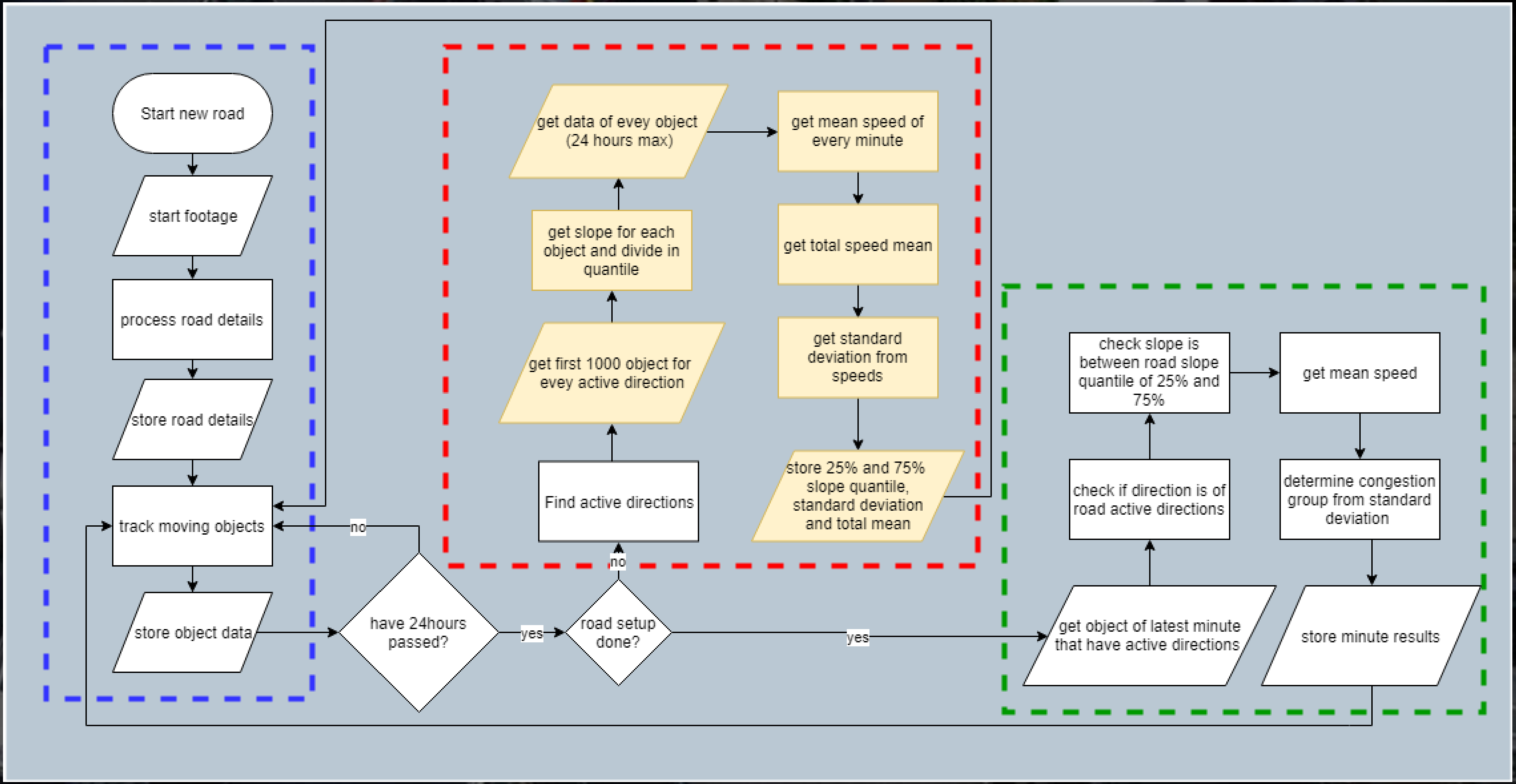
Hypothesis

We propose a cost-effective system for traffic flow estimation by gathering video feeds from surveillance cameras and track vehicles' speed though computer vision. To maximise road coverage an automated setup was developed for new roads.

Research Questions:

- How can the setup be fully automated?
- How can you accommodate different road layouts and camera perspectives?
- How can you classify traffic congestion on all roads?

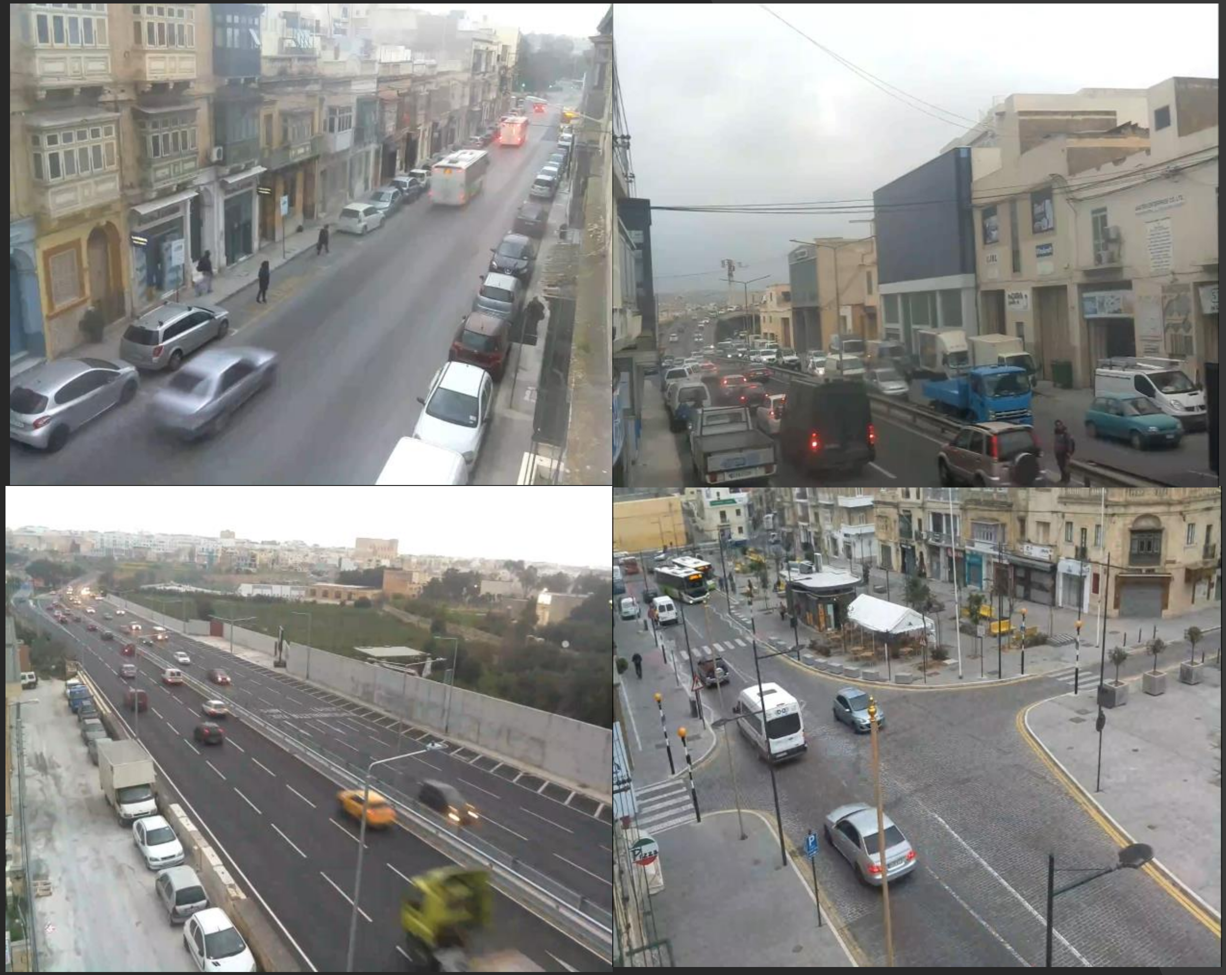
Methodology: Approach



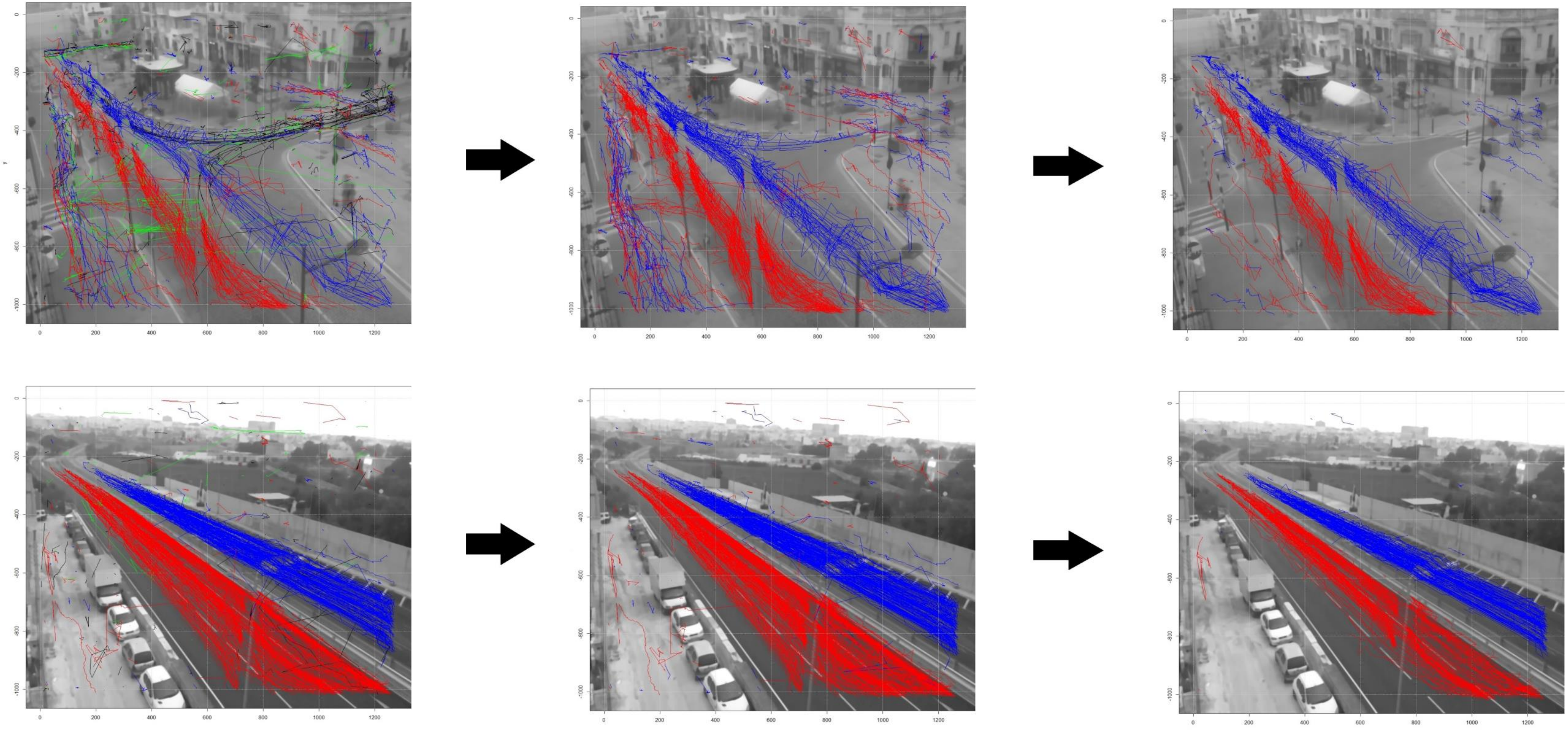
Datasets

Video footage from four roads was collected to conduct test and a comparison with Google map’s traffic

- **154 hrs of footage**
- **408 video clips**
- **Recorded in 6 days**



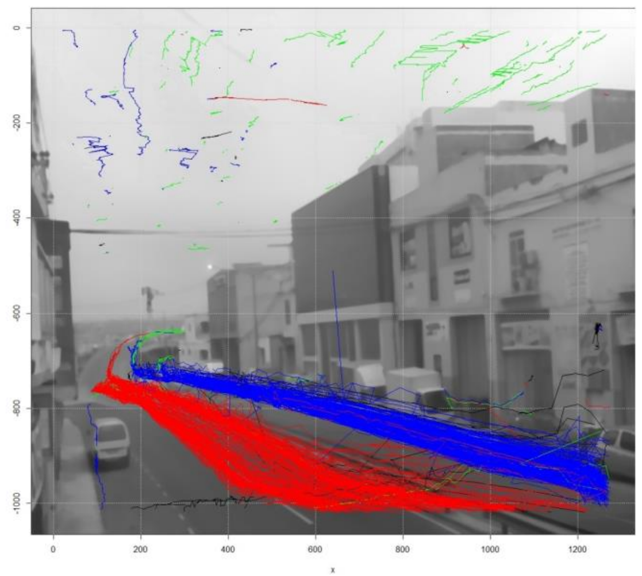
Tracked Paths Direction filtering Slop filtering

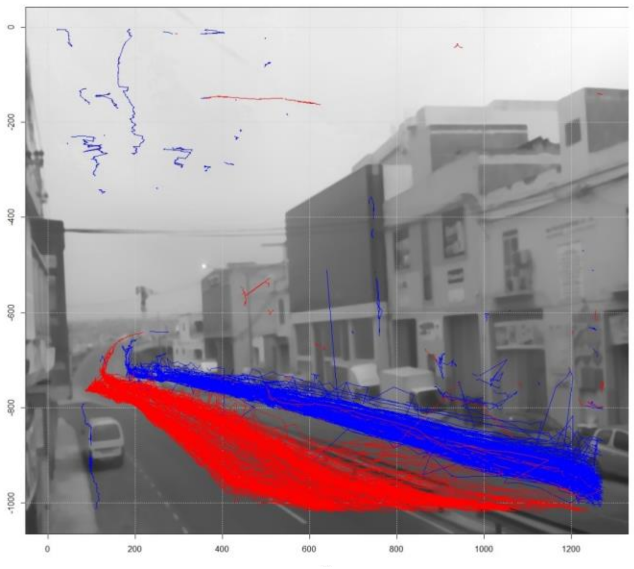


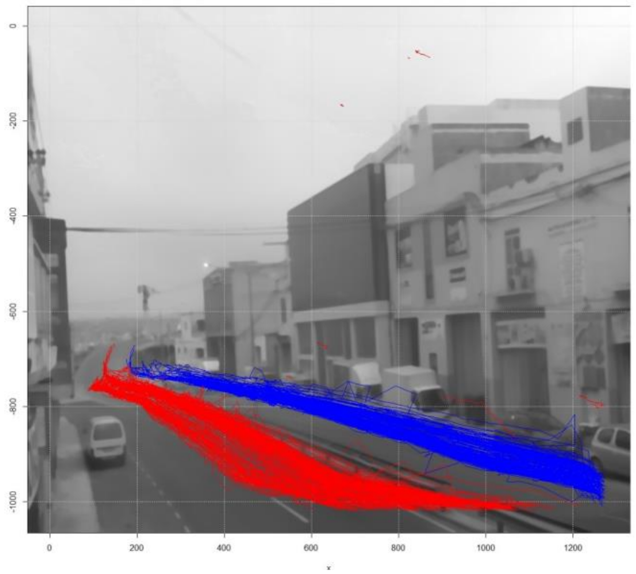
Tracked Paths

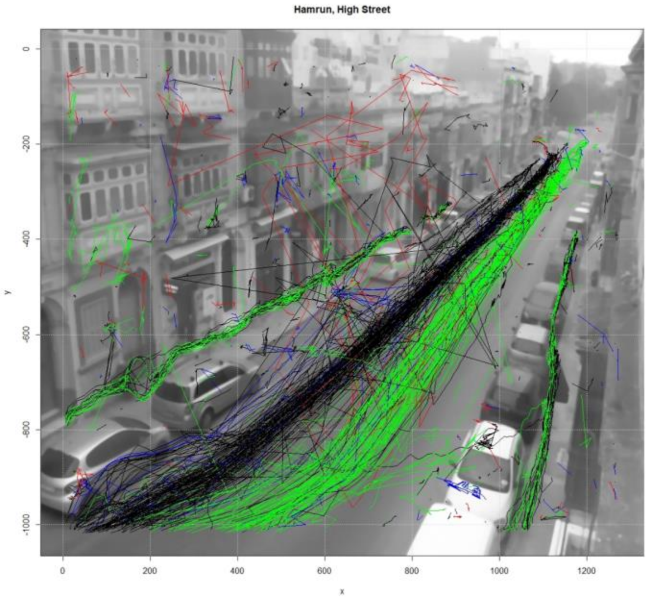
Direction filtering

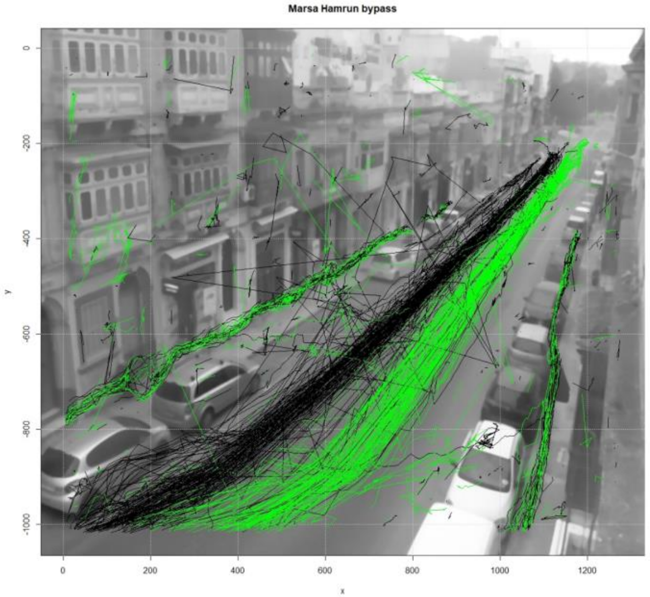
Slop filtering

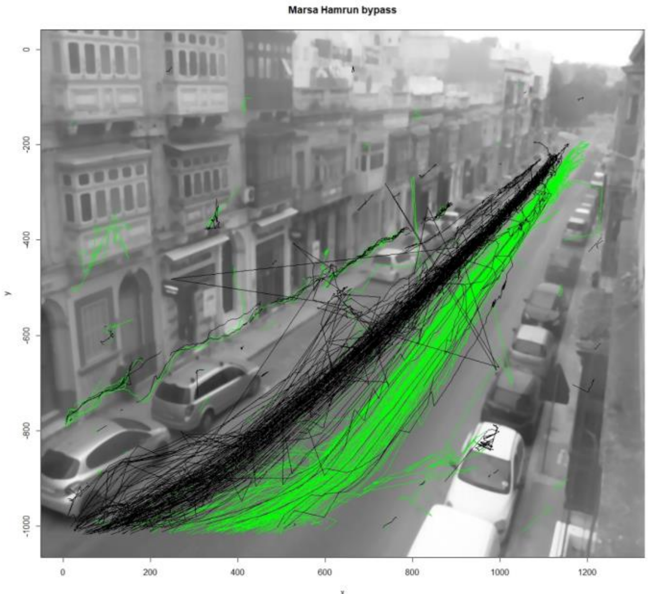




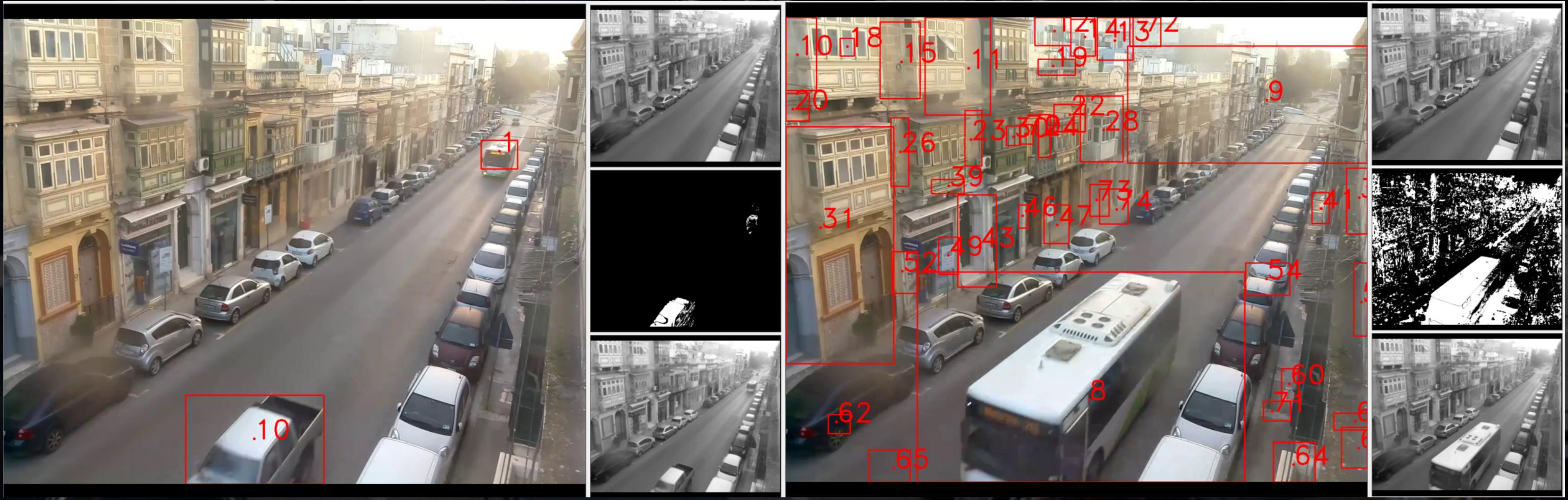




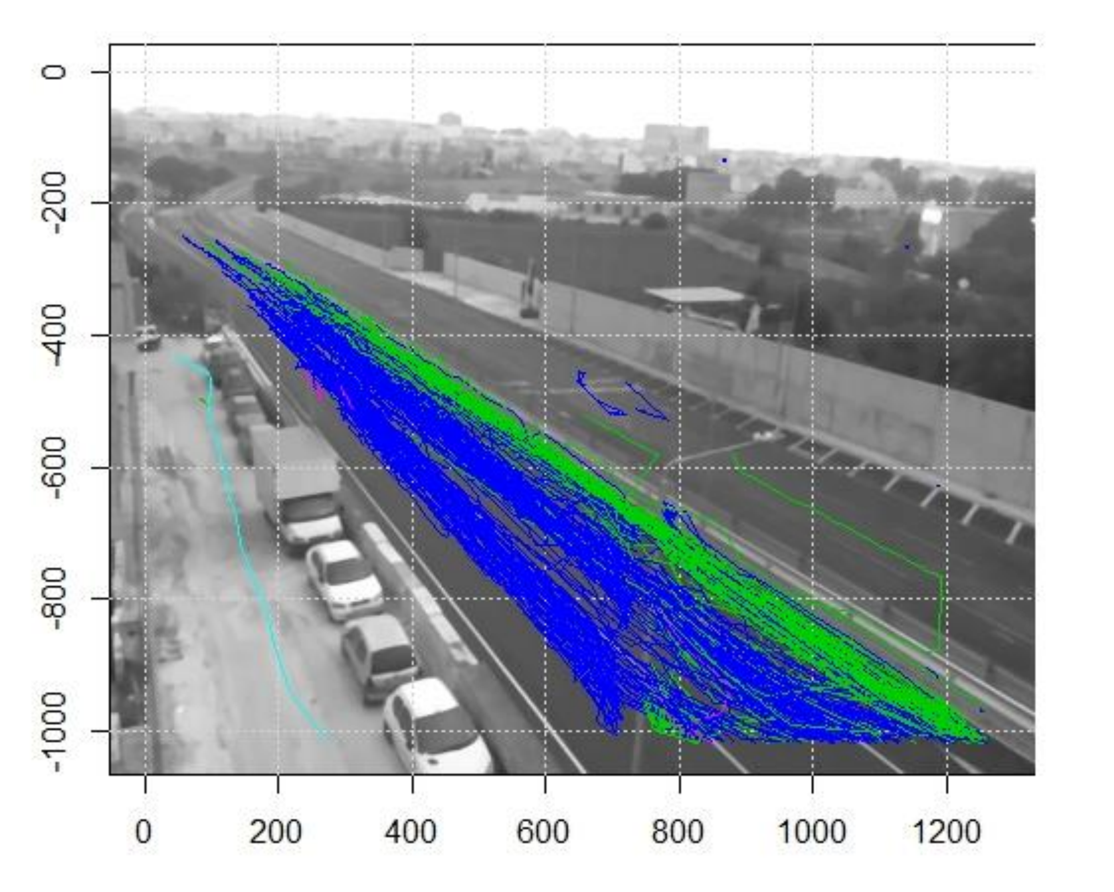




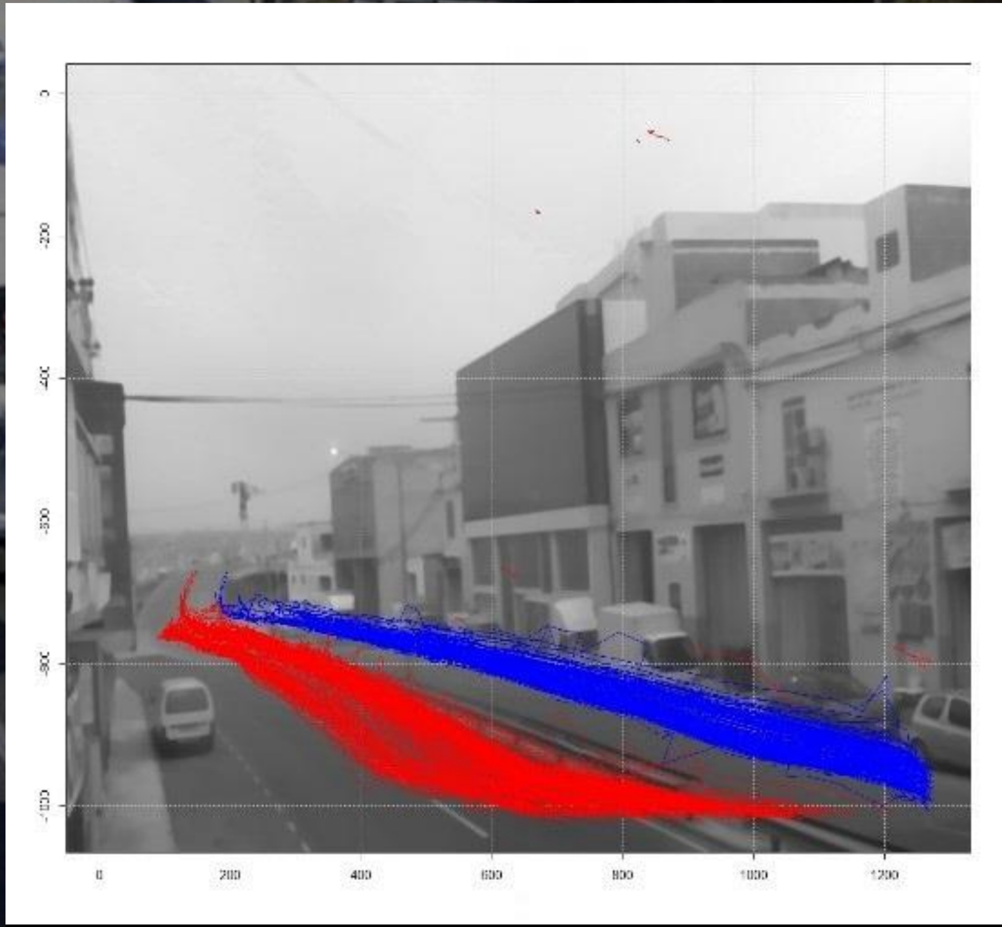
Camera movements



Lane detection with background reduction



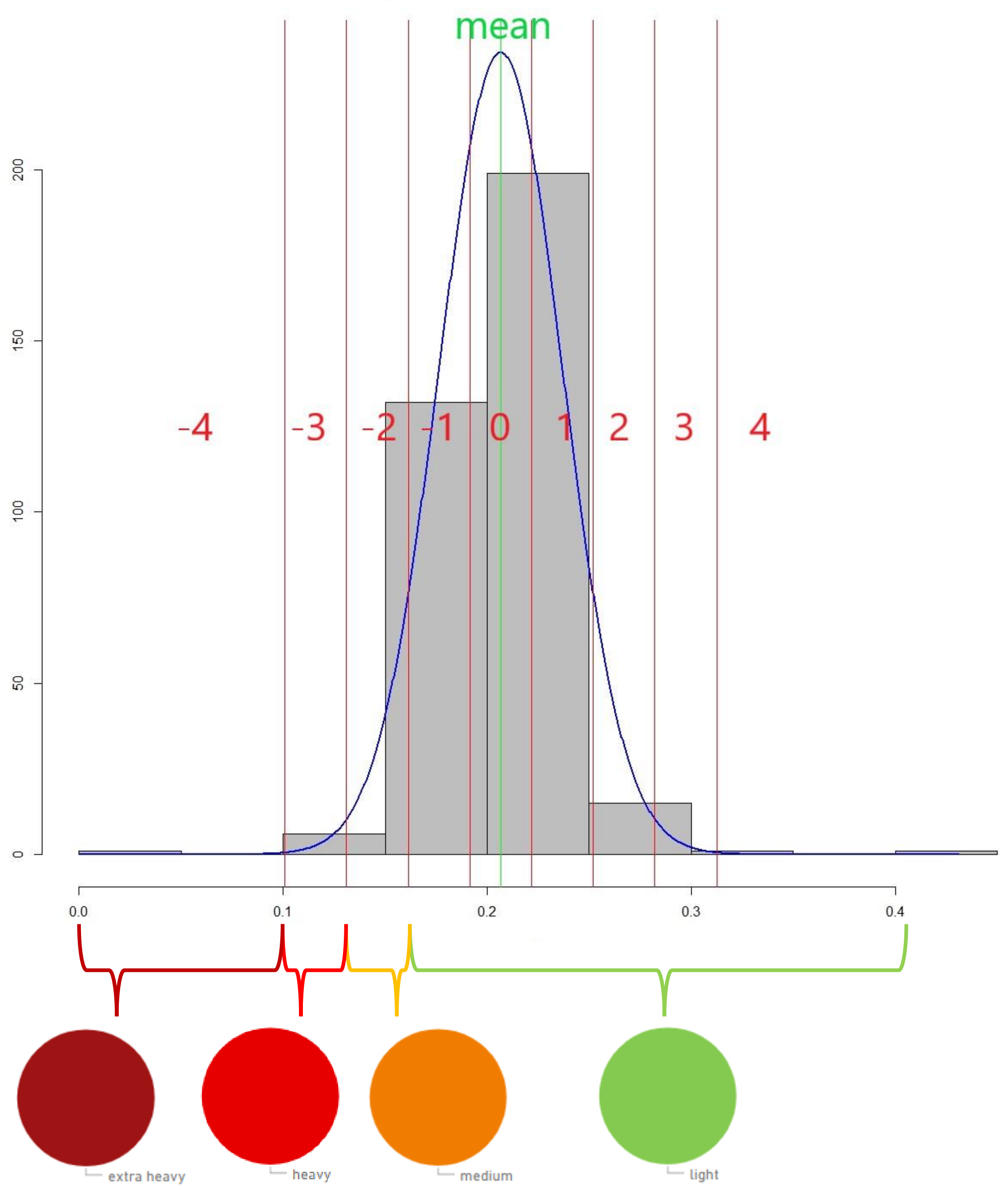
Unsuccessful unassisted lane detection



visualization of the difficulty to distinguish lanes

Traffic Flow classification

- Since we have no distance we used pixels per millisecond as speed
- Average speed form the first day of monitoring
- Standard Deviation from the average speed of every minute
- The standard deviation groups where further categorized in four groups



Our method compared to Google traffic and manual grading

	Accuracy	Precision	Recall	FPR	FNR	F1-Score
Weekday	85.49%	70.98%	70.98%	9.67%	29.02%	70.98%
Weekend	86.53%	73.06%	73.06%	8.98%	26.94%	73.06%

Our method vs Google Map's traffic, overall results

Method	Runtimes	Proccessor
Dynamic Texture Method	193	2.16 GHz dual core, 1GB RAM
Macroscopic & Microscopic Parameters	119	2.16 GHz dual core, 1GB RAM
Mixture of Dynamic Texture Models	8.19	NVIDIA Tesla C2070 GPU, 448 cores, 5376 MB Memory
Block Variance	12.5	2.40 GHz Intel i3, 4 GB RAM
Proposed Method	14.6	2.80 GHz Intel i37 quad core, 16 GB RAM

Performance comparison, from Garg et al. (2016)

	Accuracy	Precision	Recall	FPR	FNR	F1-Score
Our Method	86.53%	73.06%	73.06%	8.98%	26.94%	73.06%
Google	78.37%	56.74%	56.74%	14.42%	43.26%	56.74%

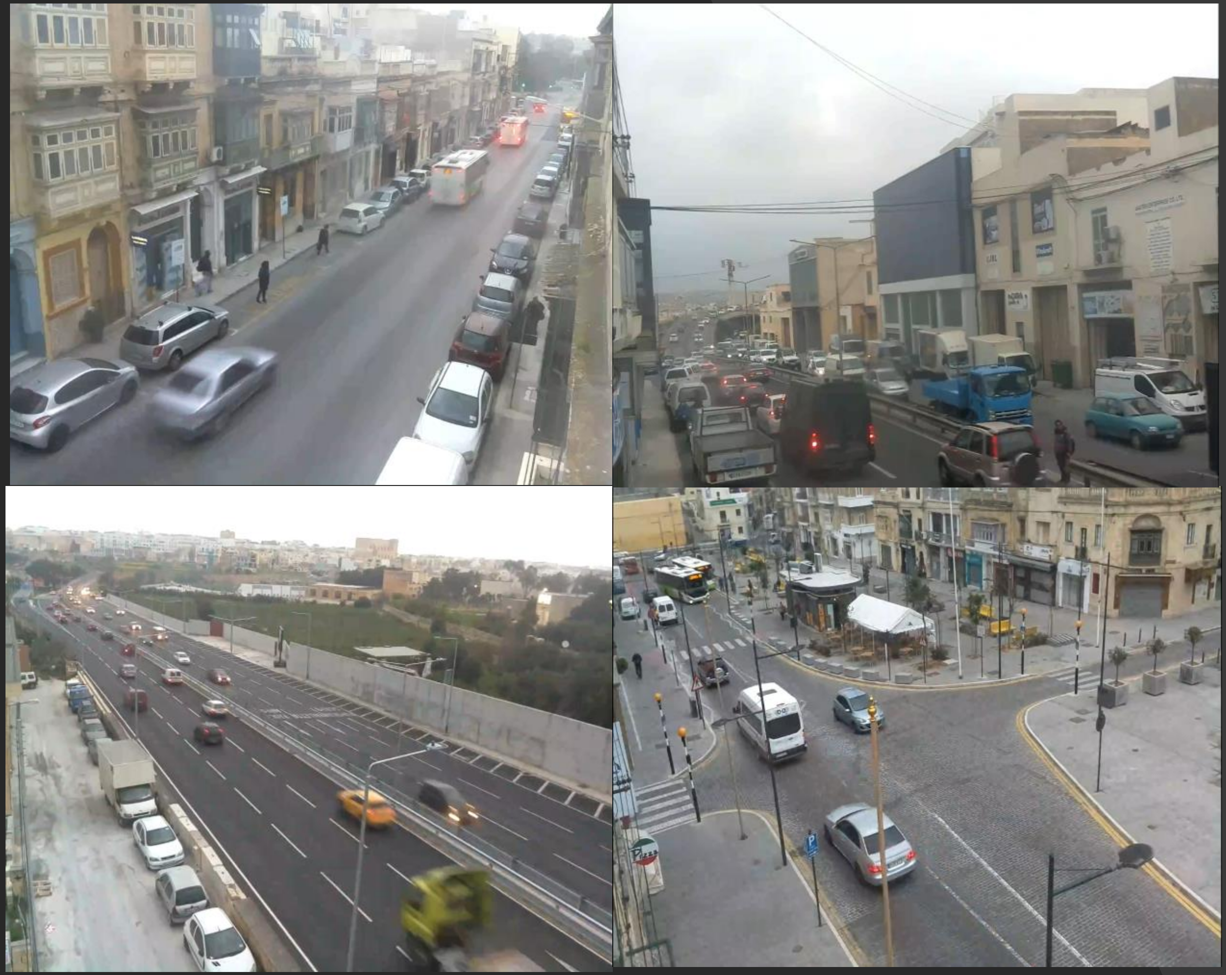
Our method vs Google Map's traffic, overall results

our	google traffic	manual
light	light	light
heavy	heavy	heavy
light	light	light
medium	extra heavy	medium
light	medium	light

Sample of comparison

Conclusion

- We successfully filtered the right directions and reduced pedestrian noise by the use of the path slop
- Successfully classified congestion in each road, with consistent results and improvement on Google map, especially in rural roads.
- Unassisted lane detection requires further research.
- Improved object detection can further improve results.



References

Garg, K., Lam, S.-K., Srikanthan, T. & Agarwal, V. (2016), Real-time road traffic density estimation using block variance, in ‘2016 IEEE Winter Conference on Applications of Computer Vision (WACV)’, IEEE, pp. 1–9.

He, F., Yan, X., Liu, Y. & Ma, L. (2016), ‘A traffic congestion assessment method for urban road networks based on speed performance index’, Procedia engineering 137, 425–433.

Melo, J., Naftel, A., Bernardino, A. & Santos-Victor, J. (2004), Viewpoint independent detection of vehicle trajectories and lane geometry from uncalibrated traffic surveillance cameras, in ‘International Conference Image Analysis and Recognition’, Springer, pp. 454–462.

Hsieh, J.-W., Yu, S.-H., Chen, Y.-S. & Hu, W.-F. (2006), ‘Automatic traffic surveillance system for vehicle tracking and classification’, IEEE Transactions on Intelligent Transportation Systems 7(2), 175–187.

Wang, Q., Wan, J. & Yuan, Y. (2018), ‘Locality constraint distance metric learning

for traffic congestion detection’, Pattern Recognition 75, 272–281.

Thank you

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