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Analysis of cyclist peloton configuration on two-lane rural roads

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1 INTRODUCTION

In Spain, most of the fatalities caused by road crashes (80%) occurred on two-lane rural roads, which represent about 90% of the Spanish road network. Currently, the number of cyclists involved in road accidents is on the increase (Figure 1), mainly due to the rise in the bicycle traffic volume during last years, generally due to sport and leisure activities. In 2015, there were 7,186 crashes involving cyclists considering all types of roads. Despite most crashes (72%) occurred in urban areas, 48 of the 58 fatalities took place on two-lane rural roads.

Although bicycles are more used in urban environments, cycling on rural roads represents a serious safety concern with near 45 deaths a year. In fact, the fatality rate involving bicycles is quite higher in rural roads than in urban environments, which may be due to the higher speed differential with motor vehicles. Some authors like Ata and Langlois [1] have reported that the higher fatality rate is due to this speed differential as well as the distance to the overtaking vehicle.

Boufous et al. [2] identified that only 5% of bicycle crashes in Victoria region (Australia) took place on two-lane rural roads, but their severity was higher. Approximately 46% of rural crashes were severe injury crashes, compared to 33% for the urban ones. The authors stated that the speed differential was the main reason. Tin Tin et al. [3] reported that rural roads presented a lower risk than urban streets, but they did not study crash severity.

Despite the higher severity of bicycle crashes on rural roads, it remains with little research since most studies just focus on urban areas because of the higher demand. However, there are some regions where rural cycling is not negligible, being an important safety concern.

Walker [4], Chapman and Noyce [5], Walker et al. [6] and Llorca et al. [7] studied how a motor vehicle overtakes a bicycle considering different factors, such as cross-sectional features, driver gender and traffic volume. In these cases, a bicycle was equipped with video cameras and other devices in order to measure the distance to the motor vehicles at the passing manoeuver.

Recently, Dozza et al. [8] used a bicycle equipped with Lidar sensors. This technology allows to collect more accurate data. They analyzed a total of 154 overtaking manoeuvers between a motor vehicle and a single bicycle. They did not analyze other configurations of bicycles such as pairs or pelotons and the relative speed between the motor vehicles and the bicycles was not considered.

Other studies were performed from video cameras located at fixed points. To this regard, Kay et al. [9] analyzed whether the cyclists invaded the opposite lane or not. Thereby, they concluded that this phenomenon was neither related to the opposing traffic volume nor the available sight distance.

Examining vehicle-bicycle interaction becomes very challenging when bicycles are forming pelotons. These groupings may change their size, shape and relative speed along their itinerary, which is of a major interest for road safety. Using GPS tracking devices could be a solution, but it might bias bicyclists. However, more and more people are tracking their leisure and exercise activities with fitness apps that have Global Positioning Systems (GPS), which also extends to cyclists, uploading tens of thousands of running and cycling trips every day. One popular company called Strava sells their data in an anonymized and aggregated format. They also provide a portion of their data for free. Therefore, it becomes a large naturalistic database that can be used to study pelotons.

Clarke and Steele [10], Cintia et al. [11], Jestico et al., [12] and Haworth [13] have used Strava data with different objectives, but all of them have focused on urban areas where cycling traffic, trip purposes, average speed, etc., differ from rural areas. In order to calibrate Strava data a naturalistic data collection will be performed.

This study aims to analyze the evolution of bicyclist pelotons along rural road itineraries using naturalistic data provided by Strava. Different configurations and sizes of cyclist groupings, such as pairs, pelotons, or long queues will be analyzed.

2 METHODOLOGY

In order to examine the accuracy of Strava data, two approaches were performed. In both cases, several two-lane rural roads located in the Valencian Region (Spain) are considered in the study. This area is popular for recreational cycling and is commonly used by groups and individuals for training. These road sections have been divided into 15 homogeneous segments according to their horizontal and vertical alignment (Table 1).

Table 1: Vertical alignment characterization

Vertical alignment description			
Level terrain	Rolling terrain	Upgrade	Downgrade
$-3 < g < 3$	$g < -3$ and $g > 3$	Always $g > 0$	Always $g < 0$
where g is the longitudinal grade (%)			

In the first step, a set of 15 volunteers who belong to a cycling club rode an entire cyclist itinerary recording their track with GPS (after uploaded to Strava) and a GPS-equipped camera. As a result, two tracks at 1 Hz interval will be recorded for every cyclist. According to Llorca et al. [7], this data collection does not alter cyclist performance or behavior. The time-space diagram will be developed for every single track, thus allowing the researchers to gain insight about the accuracy of Strava data, in terms of x-y coordinates and time.

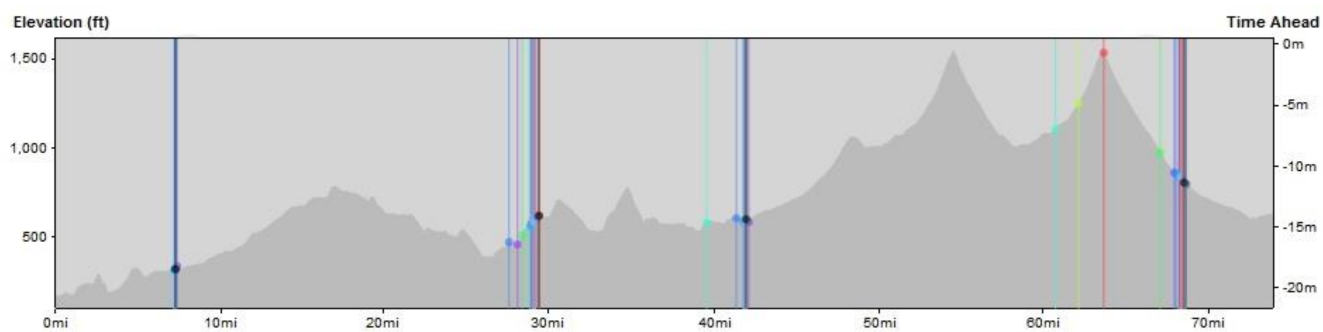

Figure 1: Evolution of the same peloton along a certain itinerary (obtained from Strava Flyby).

In the second part of the study, the researchers examined the evolution of pelotons along established itineraries only using Strava data. Using the time-space diagram, it is possible to determine how the peloton length varies according to longitudinal grade, length of the grade, and number of cyclists. The rate of Strava users of the peloton play an important role here, so hidden cameras were placed at certain spots of the itinerary to check this rate and apply the corresponding corrections. This also allows the researchers to validate the peloton time intervals obtained from the time-space diagram.

3 CONCLUSIONS

This study aims at determining how Strava naturalistic data could be used to estimate the cyclist peloton configuration and evolution along itineraries. Using this methodology, researchers would be able to collect very useful cycling data with minimum time and costs.

REFERENCES

[1] M.K. Ata and R.G. Langlois, "Factoring Cycling in Transportation Infrastructure : Design Considerations Based on risk Exposure", *ITE Journal*. August 201 (2011) 49–53.

[2] S. Boufous, L. de Rome, T. Senserrick and R. Ivers, "Risk factors for severe injury in cyclists involved in traffic crashes in Victoria, Australia", *Accident, Analysis and Prevention*. 49 (2012) 404–9. doi:10.1016/j.aap.2012.03.011.

[3] S. Tin Tin, A. Woodward and S. Ameratunga, "Incidence, risk, and protective factors of bicycle crashes: findings from a prospective cohort study in New Zealand", *Preventive Medicine*. 57 (2013) 152–61. doi:10.1016/j.ypmed.2013.05.001.

[4] I. Walker, "Drivers overtaking bicyclists: objective data on the effects of riding position, helmet use, vehicle type and apparent gender", *Accident, Analysis and Prevention*. 39 (2007) 417–25. doi:10.1016/j.aap.2006.08.010.

[5] J.R. Chapman and D.A. Noyce, "Observations of Driver Behavior During Overtaking of Bicycles on Rural Roads", *Transportation Research Record: Journal of the Transportation Research Board*. 2321 (2012) 38–45. doi:10.3141/2321-06.

[6] I. Walker, I. Garrard and F. Jowitt, "The influence of a bicycle commuter's appearance on drivers' overtaking proximities: an on-road test of bicyclist stereotypes, high-visibility clothing and safety aids in the United Kingdom", *Accident, Analysis and Prevention*. 64 (2014) 69–77. doi:10.1016/j.aap.2013.11.007.

[7] Llorca, C., Angel-Domenech, A., Agustin-Gomez, F., and Garcia, A. (2017), "Motor vehicles overtaking cyclists on two-lane rural roads: Analysis on speed and lateral clearance", *Safety Science*, 92, 302-310.

[8] M. Dozza and J. Werneke, "Introducing naturalistic cycling data: What factors influence bicyclists' safety in the real world?" *Transportation Research Part F: Traffic Psychology and Behaviour*. 24 (2014) 83–91. doi:10.1016/j.trf.2014.04.001.

[9] J.J. Kay, P.T. Savolainen, T.J. Gates and T.K. Datta, "Driver behavior during bicycle passing maneuvers in response to a Share the Road sign treatment", *Accident, Analysis and Prevention*. 70C (2014) 92–99. doi:10.1016/j.aap.2014.03.009.

[10] Clarke, A. and Steele, R. (2011), "How personal fitness data can be re-used by smart cities" *7th International Conference on Intelligent Sensors, Sensor Networks and Information Processing*, pp. 395-400.

[11] Cintia, P., Pappañardo, L. and Pedreschi, D. (2013), "Engine matters: A first large scale data driven study on cyclists performance", *IEEE 13th International Conference on Data Mining Workshops*, pp. 147-153.

[12] Jestico, B., Nelson, T., and Winters, M. (2016), "Mapping ridership using crowdsourced cycling data", *Journal of Transport Geography*, vol. 52, pp. 90-97.

[13] Haworth, J. (2016), "Investigating the potential of activity tracking app data to estimate cycle flows in urban area", *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, pp. 515-519.