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Video-based assessment of cyclist-tram track interactions in wet road conditions

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1 INTRODUCTION

Cyclist underreporting of lower severity and single cyclist collisions to police results in the underestimation of the societal costs of lower severity and single cyclist collisions [1], [2]. Prevention strategies for these types of collisions are becoming a popular area of research, and video-based approaches have obvious potential for these cases, allowing for detailed analyses of underreported lower severity and single cyclist falls. Video-based studies have been used to investigate site-specific cyclist safety issues such as railway crossings [3]. They have also been used for near-collision or near-miss incidents and Surrogate Measures of Safety (SMoS), e.g., [4]. A recent Irish study has identified the most common collision configurations and factors with the inclusion of unreported cases [5]. Findings indicate that falls involving interactions with light rail tram tracks are common in Dublin; they were the most common infrastructural collision partner in this study and a contributing factor in 23% of single cyclist collisions (ibid.), supplementing international findings [6], [7]. Furthermore, along with increasing popularity of cycling, many new light rail systems are being implemented across Europe as part of a broader move towards sustainable transport [8]. Accordingly, further investigation is required to avoid potential conflicts. Therefore, this study aims to use video-based assessment to correlate fall risk with trajectories and crossing angles.

2 METHODS

2.1 Data collection

Traffic camera footage was collected in October/November 2021 following institutional ethical approval. This involved manual screening, annotation and extraction of cyclist interactions with tram tracks from 9 traffic cameras in Dublin City Centre. We focused on weekdays, daylight conditions and peak commuting hours [1]. Wet road conditions are a significant factor for cyclist falls on tracks (21% of cases) [5]. We initially assessed a sample that included both dry and wet conditions but a significant preliminary analysis found no falls during dry conditions. Therefore, we focused on periods with wet road conditions.

2.2 Frequency and risk analysis

Using the footage, exposure and time-based risk analyses were performed to assess the rate of unsuccessful crossings (falls and near-falls involving evidence of loss of control) at each recording site.

2.3 Crossing angles and trajectories

Footage of unsuccessful crossings, and a random sample of the successful crossing cases were extracted for analysis. T-Analyst software (developed in the European InDev project) was used to calculate cyclist velocities and trajectories [9]. T-calibration allows for ground-plane calibration of monocular traffic camera footage from manually annotated scene points in both the traffic camera footage and a scaled satellite image of the recording location (e.g. Google Earth) [10] (see Figure 1). An independent-samples t-test was used to compare mean crossing angles between successful/unsuccessful crossings ($\alpha = 0.05$).

3 RESULTS

Table 1 is a summary of the collected data. A total of 2905 cyclist interactions with tram tracks were surveyed over two periods with wet road conditions. Extracted footage includes all 13 unsuccessful crossings (UC - 9 near fall cases, and 4 fall cases), and a random sample of 2,891 successful crossings (SC) for a case-control analysis. A total of 9 unsuccessful crossings were identified over Period 1 out of 2741 cyclists, corresponding to an UC rate of $3.3x10^{-3}$, or 3 in 1000. A disproportionally high rate was observed in camera 6 (Westmoreland St./College St.) (4 UCs for 213 cyclists), therefore, a further 5 hours of footage was examined in this location (Period 2). Overall, this location has a UC rate of $2.1x10^{-2}$, or 21 in 1000.

Table 1: Summary description of the study data.

Camera	No. cyclists	Hours	UC	SC sample	UC/No. cyclists	UC/Hour
1	198	7	1	10	0.0051	0.1429
2	145	7	0	7	0	0
3	181	7	1	9	0.0051	0.1429
4	116	7	0	6	0	0
5	410	7	1	21	0.0024	0.1429
6	377	12	8	19	0.0212	0.6667
7	324	7	1	16	0.0031	0.1429
8	551	7	1	23	0.0018	0.1429
9	603	7	0	30	0	0
Total	**2,905**	**68**	**13**	**141**	**0.0045**	**0.1912**

As a preliminary analysis, trajectories of 5 unsuccessful crossings and a random sample of 7 successful crossings of the inside track were annotated for camera 6 (Figure 2). Mean crossing angles were higher for successful crossings ($\bar{x}$ = 17 degrees, SD = 3.70), compared to unsuccessful crossings ($\bar{x}$ = 9 degrees, SD = 6.37), with statistical significance ($p = 0.017$). Average velocities were similar: 4.2m/s for successful crossings vs. 4.1m/s for unsuccessful crossings.

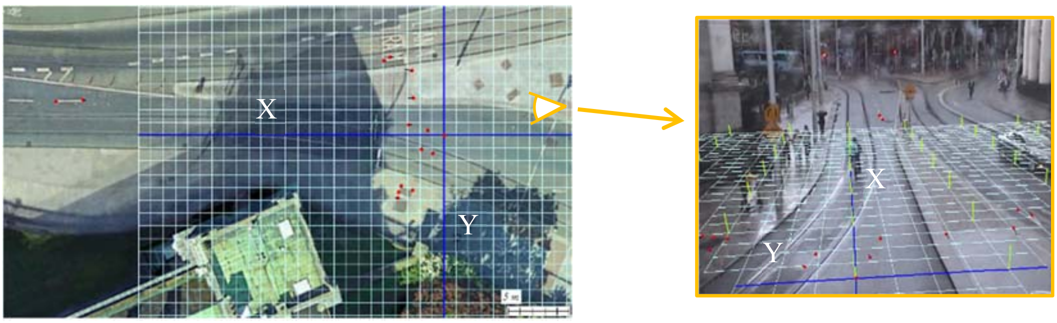

Figure 1: Ground plane calibration for Westmoreland St./College St. (camera 6).

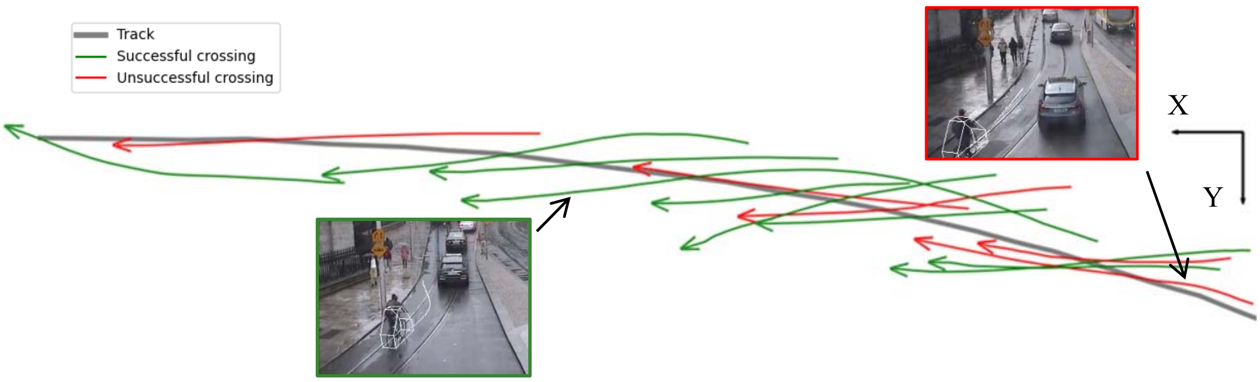

Figure 2: Trajectory analysis of cyclist interactions with the inside track at Westmoreland St./College St. (camera 6).

4 DISCUSSION & CONCLUSIONS

We present the first video-based trajectory and fall analysis for cyclist interactions with light rail tram-tracks. Our analysis focuses on wet road conditions as a common and safety critical edge case. Though rates are lower than a similar study in the US for railway tracks [3], cycling volumes in the study areas resulted in a high number of unsuccessful crossings. High overall incidence numbers for unsuccessful crossings over this short study period with limited coverage of the track network highlight the significance of the safety issue, particularly in Westmoreland St./College St (camera 6). Furthermore, an additional unsuccessful crossing was noted in a nearby camera (camera 5: Grafton St./College Green.). As expected, our further analysis of crossing trajectories for camera 6 indicates that crossing angle is a predictor of crossing success. Furthermore, falls on the inside kerb are common here, and all crossing angles are low for both successful and unsuccessful crossings (≤ 20 degrees - excluding one case with intentional mounting of the kerb). This is likely due to the proximity of the nearside kerb, which limits crossing angle. These findings indicate that crossing angle could be used as a SMoS (i.e., a safety-related indicator without the need for fall footage), allowing for rapid assessment of potential areas of conflict. Future work will include a complete trajectory analysis of the data at all study locations, to supplement these findings and determine site-specific safety issues.

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