Bicycle crash clustering using ellipses in computer vision

Introduction Bicycle usage carries several benefits, from less traffic congestion in cities, less polution, healthier lifestyle, among others.

However, cyclist are vulnerable road users, which crash rate is in increase [**?**].

For this reason, research in the field of bicycle crashes during the 15 last years have gained popularity.

Within the types of bicycle crahes, one that stands out is the Single-actor bicycle crash, where no other road user is involved.

Up to this date, the information concerning this type of events is limited.

Most studies focus on statistics in a city infrastructure-based approach or human injuries.

However, none of these approaches take into account the particular behaviour of bicycles.

Understanding the behaviour of bicycle in crash scenarios will enhance research quality in the field and increase road safety.

To this end, it is necessary to first understand frequent crash configurations and bicycle crash dynamics.

In the literature we can find several vehicular crash analyses, mainly for cars.

However, for bicycles and motorcycles, these approaches are limited, beginning with the low 'after crash' traces [**?**].

In this matter, we define crash stages based on a video datased created from public domain sources **??**.

Along with the manual inspection, we propose a new classification based on bicycle dynamics, which also includes human factors and highglights the gap on required data to understand bicycle crashes.

Method Mention somewhere here that we are using instance segmentation.

- Dataset creation

This research have been based on public domain bicycle crashes audiovisual content.

We created a datased composed mainly of YouTube videos, with the posibility of expanding it in a user-friendly way.

Using this dataset, several single-track vehicle dynamics experts were asked to classify the events according to the proposed approach.

- Video labelling

To train the computer vision algorithm, several bicycle videos of normal riding and crash scenarios were labeled.

We use the ellipse labelling approach, taking advantage from neural networks already trained to detect wheels from side view.

Assuming that the majority of the bicycles use wheels of standarised sizes, we expect that this allows us in the future to use triangulation techniques in kinematic data extraction.

Additionally, ellipses give information about the orientation to the camera based on its excentricity.

- Supervised learning for detecting crashes

The first task to try the proposed methodology is to feed the model with labelled data of crash/ no crash.

From wheel motion in space, neglecting spinning for technical constraints (image quality), we can detect if the image corresponds or not to a crash.

- Unsupervised (clustering) for classifying crashes and compare with literature.

Using detected crashes and the previously mentioned dataset, we use clustering techniques to identify different crash configurations.

We expect to link these clusters to the previously developed classification.

Results

- This methodology allows us to detect common crashes from side-view perspectives.

With this work, we create a comprehensive bicycle dynamics-oriented base of technical requirements for crash analysis.

The stages of a bicycle crash are identified: Excitation creates critical scenario, mechanism and motion are the crash characteristics, while the post crash is mainly related to human motion and outcome.

With this classification we highlight the necessity of data on bicycle crashes.

- Pitch over crashes are easier to identify

Using the ellipse-based approach, pitch-over crashes present a higher prediction accuracy.

Discussion

- Bicycles are particularly challenging for computer vision tasks
- This is a new approach that have not been done before.

- Combining this with triangulation methods can open the door for kinematics extraction.
- Limitations: Side view, not longitudinal slip detection, image quality.
- Camera motion

Conclusion This approach seems to be promising for the desired task.

It is necessary to increase dataset size.

Events with large longitudinal and/or vertical motion of the bicycle are more easy to identify.

References European Commission (2024) Facts and Figures Cyclists. European Road Safety Observatory. Brussels, European Commission, Directorate General for Transport.