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TOWARDS COMPUTATIONAL MODELLING OF ACTIVE RESPONSE IN CYCLIST FALLS FROM IN-THE-WILD FOOTAGE

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Introduction

The self-protective effects of active response in unplanned falls is a well-established, yet under-researched area [1,2]. Our recent study demonstrated how single cyclist falls are prevalent (i.e., cyclist road traffic collisions not involving another road user) [3], and that active response is of particular importance in these cases [4]. This phenomenon has not been considered in previous computational modelling studies involving passive multibody models. Multibody dynamics solvers implement the equations of motion as an initial value problem, and it is known that resulting impact kinematics and dynamics are influenced significantly by initial posture and motion [5].

In recent years, many deep learning and computer vision-based 3D human pose estimation methods have been developed [6]. These techniques allow for inference of joint positions from monocular/stereo camera footage. In this study, we develop a pipeline for applying joint degrees of freedom (DOFs) and their 1st derivatives (linear and angular velocity) to represent active response using Madymo's pedestrian multibody ellipsoid model. As demonstration, we apply this to monocular footage of 30 cases of cyclist falls on railway tracks from [7].

Methods

Footage was spatially calibrated with respect to the ground-plane using the approach from [8], whereby scene points on the ground plane are manually annotated in both camera footage and a satellite image of the recording location (obtained from Google Earth). GAST-Net [9] was applied to obtain 3D poses. This is a regression-based method that employs a 2D keypoint pose estimator [10] (HRNet) as a backbone and lifts these estimates to 3D. To improve accuracy of the 3D pose estimates we manual repositioned 2D poses.

A temporal inverse kinematics (IK) optimization technique was developed to infer joint orientations in the Madymo multibody model to match the pose [11]. Linear and angular velocities were defined using the central difference method, and output as .xml include files for interpretation by the Madymo solver. The pipeline is demonstrated in Fig.1.

Discussion

The findings indicate that the limbs are used to prevent falls, absorb impact energy and protect the head in the case of single cyclist falls. This is supported by findings from our analysis of single cyclist fall types [4]. The kinematic forms characterized in this study can be used to inform initial conditions for computational modelling and injury estimation in single cyclist falls.

We have developed a novel pipeline which allows for semi-automatic inference of human kinematics from in-the-wild video footage for reconstruction in Madymo. This approach can be applied to a variety of impact biomechanics tasks not limited to cyclist falls.

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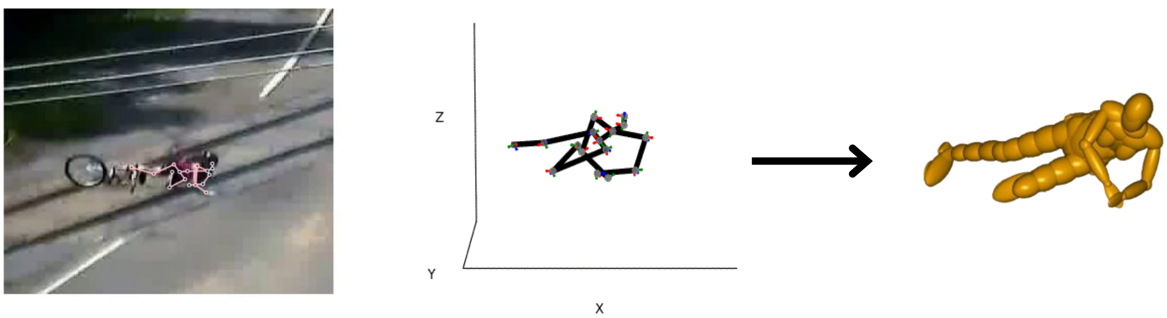

Figure 1: Pipeline for reconstruction of cyclist falls from monocular camera footage.