Submission ID: 30

Lund, Sweden
10-12 November 2021
iCSC International Cycling Safety Conference

Fall detection for a side-impact airbag in cycling

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Keywords: airbag, mounting and dismounting falls, fall detection, experimental study, elderly

Many accidents among elderly on e-bikes happen at slow speed, while stopping and starting, and during mounting and dismounting. An airbag could protect the cyclist against hip or pelvis fracture. Such a hip-airbag has been developed by WOLK, to handle activities in daily living for elderly on foot, like during walking, sitting down, standing up, etc. Characteristics of the WOLK hip-airbag are: it can be worn under clothing, has a built-in wireless alarm function with GPS tracking, is washable and reusable. A crucial part of such an airbag is the fall detection algorithm. The current algorithm is tailored for walking that is for elderly on foot, and has shown to be very successful there. If the hip-airbag would be applied in cycling the question arises if the current fall detection algorithm is also applicable for cyclist falling at slow to zero speed and during (dis)mounting. Therefore our research question is: How well is the current fall-detection algorithm able to detect falls in cycling at slow to zero speed in (dis)mounting (true positives) and how sensitive is the current algorithm to activate during cycling related activities that are not falls (false positives)?
For this purpose an experimental study has been set up where the rider had to (dis)mount the bicycle. Soft cushions were placed on either side of the stopping location to catch the fall of the rider. The bicycle used was an e-bike with a step through frame with soft padding on the frame to minimize the risk of injury. Two strategies for (dis)mounting were studied. The first is where the rider, with one foot on the pedal, with the other leg steps through the frame whereas the second is where the rider swings this leg over the saddle and rear rack. The bicycle fall data generated by the inertial measurement unit (IMU) from the WOLK hip-airbag were analysed and compared with walking falls. With eight participants a total of 99 bicycle falls and 142 walking falls were recorded and analysed. The results show that the percentage of falls detected by the WOLK algorithm for bicycle falls as compared to walking falls were similar, both 73%. Late fall detection in cycling was higher than in walking, 13% versus 4%. Consequently, in walking the percentage of falls not detected was higher than in cycling, 23% versus 13%. Hence, from these experiments it can be estimated, with a 95% confidence level, that cycling falls at (dis)mounting can be detected by the WOLK hip-airbag algorithm (on time and late) for 80% to 94% in the real population. Concurrently it can also be estimated with a 95% confidence that cycling falls at (dis)mounting will not be detected for 7% to 20% in the real population.
It is important to emphasise that there is room for improvement. Thus, future work includes investigating how speed of the E-bike with a longer runway for (dis)mounting could affect the falls/impact, how using the knee as a support to stop a fall from the bicycle hampers detection and understanding why it happens, understanding the body dynamics during bicycle falls and the relation between the height of the person and the fall from the bicycle.