Observation de la réaction pré-crash de piétons en situations d’accidents reproduites sur simulateur

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INTRODUCTION

Current Safety Procedures

• Do not account for pedestrian pre-crash reactions

• Surrogates are configured in typical walking posture

• Seems to represent a walking pedestrian unaware of the imminent accident

V/S Real Life Situations

• Live Human ➔ React

• Perception of imminent accident may lead to sudden crash avoidance reactions

➔ Affect the pedestrian pre-impact conditions

Affect the Post Crash Outcomes !!!
Objectives

- To observe and quantify pedestrian pre-crash reactions
- To assess the consequences of these reactions
  - Passive safety: influence on the injury risk
  - Active safety: pedestrian detection? Possible avoidance?
Experiments – Test set-up

- **Pedestrian walking space**

  ![Snapshot of the Pedestrian Walking Space](image)

  ![Top-down schematic view of Walking Space](image)

  - Screens: 6m x 2m
  - Track: 5m x 1m
Experiments - Test set-up

- **Subjects**
  - 12 Young (18-30 years old)
  - 11 Elderly (60-75 years old)

- **Task**
  - Cross the street, avoid the vehicles
  - 2 to 4 « virtual crashes » from both sides

- **CPP**
Experiments - Test set-up

- Virtual crashes

TRIGGER
  Target Car Appear

SOUND ON
  T = 0 sec

BALL HIT ON SCREEN
  T = 0.6 sec
  T = 1.1 sec

Audio Pulse
  95 db peak
  1 sec duration

Target Car

Launcher
  Final Position

Spring
  Magnet
Experiments - Test set-up
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- **Measurements**
  - **Kinematics**
    - Vicon system, 6 cameras, 46 markers
  - **Ground Reaction Forces**
    - 2 force plates embedded in the track
  - **Muscle activity**
    - EMG from 9 muscles
Experiments - Test set-up

- Simu
  - display
  - sound
- Vicon – Motion Analysis
  - Acquire
  - Vicon
  - Launcher
- Trigger
  - control
- Experiments - Test set-up
Data Analysis

- **Motion reconstruction**
  - 3D trajectories of markers

- **Kinematic model**
  - Kinematic linkage
  - Dimensions
  - Position of markers on the model

Optimisation
Data Analysis

- **Motion reconstruction**

  Estimation of the mannikin posture for given set of marker’s positions

  - For one frame
  - Over the whole motion
Experiments – Main results

- Analyzed data
  - 70 surprise trials recorded => 51 analysed (26 Young & 25 Elderly)
Experiments – Main results

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  • 70 surprise trials recorded => 51 analysed (26 Young & 25 Elderly)
• 3 types of reactions

Accelerate  Back out  Freeze
Experiments – Main results

- Analyzed data
  - 70 surprise trials recorded => 51 analysed (26 Young & 25 Elderly)
- 3 types of reactions

![Bar chart showing types of reactions in young and elderly groups](chart.png)

- Frequency (in %)
  - Type of Reactions: Acc., Freeze, Backout, No Reaction
  - Young: N_Yo = 26
  - Elderly: N_EL = 25
Experiments – Main results

- **Analyzed data**
  - 70 surprise trials recorded => 51 analysed (26 Young & 25 Elderly)

- **3 types of reactions**

![Graphs showing speed vs time for Young and Elderly]

Strategies can be distinguished ~700 ms after the trigger, i.e. 400 ms before impact
Multi-Body Simulations

- Influence of pre-crash posture orientation and speed on crash injuries

Pedestrian Pre-Crash Conditions

40 Cases

Baseline Case

Small Sedan Model
Simplified windscreen
(single stiffness)

Central Impact

40 Kmph

(Stepping Back)

+ $\theta$

+ $V$ (Running)
Multi-Body Simulations

- **Baseline vs. other cases**
  - Standard walking posture covers ~ 90% of the simulated cases

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<th>HIC</th>
<th>Head Linear Velocity</th>
<th>Head Angular Acc.</th>
<th>Thigh Force</th>
<th>Thigh Moment</th>
<th>Knee Angle</th>
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CONCLUSIONS

• Limitations
  – Realism of the experiments
    • Simplified simulator
    • Impact scenario ?
  – Simulation
    • Only one specific impact configuration simulated (effect of impact speed, position in front of car, car front profiles should be investigated)
    • Further investigate the bracing effect ?
CONCLUSIONS

• Main results
  
  – Database of pedestrian pre-crash reactions.
  
  – Variety of reactions but three main strategies that can be distinguished ~ 400 ms before impact.
  
  – Standard pedestrian posture seems to be close (90th percentile) to worst case situation.
Réactions de piétons jeunes et âgées en situation de pré-crash lors d’expérimentations sur simulateur

Questions ?