

Integrating IMU and Narrative Reports for Comprehensive Understanding of Real-world Fall Dynamics

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Summary

This study investigates real-world falls by integrating wearable IMU data with narrative reports from the FARSEEING real-world fall dataset, capturing 117 falls in older adults with moderate to high fall risk. IMU data revealed detailed pre-fall activities, such as turning and transitions, often simplified or omitted in narrative reports. Moderate agreement (65%, kappa = 0.59) was observed between reported and recorded activities, with IMU data uncovering key dynamics, such as incomplete or implicit transitions surrounding falls. Falls were predominantly initiated in backward or sideways directions, though most impacts occurred in the backward direction. Agreement between reported and recorded fall directions showed that narrative reports tend to describe initial, impact, or a mix of both directions. Despite differences, most falls showed partial agreement between data sources. This study highlights the value of combining objective motion data with contextual insights to better understand fall mechanisms and guide the development of effective prevention strategies.

Introduction

Understanding how and why falls occur in real-world is essential for developing effective fall prevention strategies for older adults. However, our knowledge remains limited due to a lack of objective data on fall dynamics and environmental context. This study integrates wearable IMU data with narrative reports from the FARSEEING real-world fall dataset to analyse common scenarios leading to falls and examine the fall trajectories and biomechanics. We aim to identify agreement and disagreement between IMU and narrative reports and provide a comprehensive understanding of circumstances surrounding real-world falls.

Methods

Data from 117 real-world falls, captured using a mid-back IMU sensor, were analysed with a validated sensor fusion algorithm to identify common pre-fall activities and fall trajectories. Participants (mean age: 67.43 years, 58/59 female) had moderate to high fall risk. Narrative reports provided additional context, enabling reconstruction of pre-fall scenarios and dynamics. headers.

Results and Discussion

The common pre-fall activities were stand-to-turn (27.18%), walking (18.45%), walk-turn (15.53%), and standing-up (13.59%). Moderate agreement (65%, Cohen's $\kappa = 0.59$) was found between reported and recorded pre-fall activities. Narrative reports identified walking as the most frequent pre-fall activity (35.9%), but IMU data revealed that 49% of these cases involved turning or reaching. Similarly, standing was reported in 16.5% of cases, but IMU data showed 41% included turning and 29% involved transitions such as standing up or sitting down. Overall, narrative reports often simplified pre-fall activities, such as reporting walking for navigation around furniture, or focused on intended actions, such as reporting standing as pre-fall activity instead of falling during a sit-to-stand transition. IMU data clarified these gaps by capturing implicit transitions, e.g. turning, in the reports and whether intended actions were completed before the fall.

Most falls involved rotation during descent which highlights the biomechanical complexity of falls. Falls were predominantly initiated in backward (BW) and sideways (SW) directions, with 74% of BW-initiated falls and 77% of SW-initiated falls resulting in BW impacts, suggesting a potential preference or perceived safety in landing backward [1]. Agreement between reported and recorded fall directions was observed in 44% of cases for both initial and impact directions. Initial-only and impact-only agreement were 24% and 16%, respectively, while 16% of cases showed no agreement. Despite these discrepancies, 84% of falls showed at least partial agreement.

Conclusions

The integration of IMU data and narrative reports bridges the gap between objective motion analysis and subjective contextual insights. Identifying areas of agreement and disagreement between objective and subjective data, such as distinguishing between intended and actual activities and recognizing implicit transitions in reports, can provide a comprehensive understanding of fall circumstances and ultimately contribute to the development of more effective fall prevention strategies.

Acknowledgments

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References

[1] Komisar et al. (2021). *COR. Journal*, **19(4)**:381-390.