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M A S T E R ' S   T H E S I S  
for  
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## **Postural Instability Detection in Activities of Daily Life for the Application of Vibrotactile Biofeedback - A Comparison of Machine Learning and Threshold Approaches**

### Problem description:

Falls are the second cause for injury deaths worldwide with highest mortality in elderly ( $> 60$  years) [1]. Wearable devices provide a good opportunity for people with postural instability to improve postural control in everyday life [5]. Different feedback devices have been investigated in the research area of postural control [2, 4, 5, 6]. In the context of wearable sensors inertial measurement units (IMUs) located on various parts of the body or plantar force sensors [5, 6, 7] have been widely used to measure static and dynamic balance. Commonly, feedback is given as soon as a threshold is exceeded [6]. However, to be applicable for everyday life the threshold might have to be adapted to different activities in daily life (ADL). Besides using a threshold for detecting instability and providing biofeedback, also machine-learning based methods could be a promising approach. Machine learning (ML) based methods have been investigated for fall and pre-fall detection and prediction in humans [8, 9] and humanoids [3]. Consequently the following research questions will be investigated:

- 1) How can we adapt one threshold to suit various activities of daily life?
- 1) Is a threshold based method or a machine learning based method (or a hybrid method) more accurate and reliable for providing vibrotactile biofeedback?
- 2) Is a combined threshold (pressure insoles + IMU) more reliable than a threshold based only on the pressure insoles [7]?

### Tasks:

- Literature research
- Implement a machine learning approach for instability/pre-fall detection/prediction, :
- Conduct user study with 30-60 subjects assessing different stable and unstable ADL
- Adapt the threshold to different ADL based on the relationship between the instability detected based on the limits of stability threshold and the real instability measured during various activities
- Conduct a pilot study providing real-time biofeedback with the different approaches
- Compare the different methods (threshold vs. ML (vs. hybrid)) with each other in terms of accuracy and reliability of timing a vibrotactile biofeedback

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