Classification of event location using matched filters via on-floor accelerometers

Abstract:
Recent years have shown prolific advancements in smart infrastructures, allowing buildings of the modern world to interact with their occupants. One of the sought-after attributes of smart buildings is the ability to provide unobtrusive, indoor localization of occupants. The ability to locate occupants indoors can provide a broad range of benefits in areas such as security, emergency response, and resource management. Recent research has shown promising results in occupant building localization, although there is still significant room for improvement. This study presents a passive, small-scale localization system using accelerometers placed around the edges of a small area in an active building environment. The area is discretized into a grid of small squares, and vibration measurements are processed using a pattern matching approach that estimates the location of the source. Vibration measurements are produced with ball-drops, hammer-strikes, and footsteps as the sources of the floor excitation. The developed approach uses matched filters based on a reference data set, and the location is classified using a nearest-neighbor search. This approach detects the appropriate location of impact-like sources i.e. the ball-drops and hammer-strikes with a 100% accuracy. However, this accuracy reduces to 56% for footsteps, with the average localization results being within 0.6 m ($\alpha = 0.05$) from the true source location. While requiring a reference data set can make this method difficult to implement on a large scale, it may be used to provide accurate localization abilities in areas where training data is readily obtainable. This exploratory work seeks to examine the feasibility of the matched filter and nearest neighbor search approach for footstep and event localization in a small, instrumented area within a multi-story building.