J. SNOEK, B. TAATI, A. MIHAILIDIS. Automated detection of falls in the home: Current challenges and future directions. Gerontechnology 2010;9(2):248; doi:10.4017/gt.2010.09.02.225.00

Purpose Improved medical care and the aging of the 'baby boomer' generation have resulted in the increasing size and proportion of the aged sixty-five and over population. As the older generation grows, falls in the home are becoming increasingly epidemic. A recent study has identified falls as the most expensive category of injury for the Canadian healthcare system, costing in total over $6.2 billion in 2004 alone[1]. Adults over the age of 65 accounted for the majority of the costs, 84% of fall-related deaths and 59% of hospitalizations. The prevailing type of injury-causing fall was falls on the same level, followed by falls on stairs. Under the hypothesis that immediate access to emergency healthcare after a fall will reduce the severity of injuries, promote greater independence and allow older adults to age in place for longer, there have been a number of efforts made to create automatic fall-detection systems. In past work, we have developed, and carefully optimized, computer vision based systems to detect falls in the home[2,3]. However, a number of challenges remain before the systems can be deployed in real situations. In particular, gathering enough data to train the artificial intelligence algorithms has proven to be prohibitively expensive. The variance in different people's gait and motion confuses the predictions of simple machine learning algorithms as they struggle to distinguish idiosyncratic behavior from dangerous events. More complex algorithms that model uncertainty in the data perform much better at the task of detecting dangerous events, but are computationally too expensive to use in a practical, real-time system. In this work we show that recent advances in Gaussian Processes (GP) allow us to model the uncertainty and variance in the training data. This variance indicates which training data would be most beneficial to obtain (i.e. that which most decreases the uncertainty). We demonstrate preliminary results showing that the model can be used to automatically generate new training data to improve the performance of simpler algorithms. **Method** Twenty training videos of different subjects simulating fall events, difficult borderline events (e.g. crouching and sitting) and normal gait were collected. A leave-one-out round-robin classification experiment was performed to compare the detection accuracy of two standard approaches (Logistic Regression and Support Vector Machines) with GP. **Results & Discussion** The GP outperforms the other two approaches by over 10% (from 75% to 86%) and produces a more favorable precision/recall tradeoff. We demonstrate how using a GP to generate new data allows the other algorithms to approach the accuracy of the GP. In addition, we show that by modeling the uncertainty in the training data one can identify the missing data that would be most valuable to improve the performance of the system.

References

1. SMARTRISK. The Economic Burden of Injury in Canada. Toronto: SMARTRISK; 2009
2. Lee T, Mihailidis A. An intelligent emergency response system: preliminary development and testing of automated fall detection. Journal of Telemedicine and Telecare 2005;11(4):194-198
3. Snoek J, Hoey J, Stewart L, Zemel R, Mihailidis A. Automated detection of unusual events on stairs. Journal of Image and Vision Computing 2009;27(1-2):135-166

Keywords: gait analysis, learning algorithms, fall detection, Gaussian Processes (GP)

Address: University of Toronto, ON, Canada; E: jasper@cs.toronto.edu