Readily Implementable Fall Detection System for the Elderly using Thermal Image Segmentation and Convolutional Neural Networks

Vel, Vetri (School: Bangor High School)

Over a quarter of older adults in the US fall each year and falls are the second leading cause of injury deaths worldwide, with 80% of deaths in low- and middle-income countries. Quick assistance after a fall is critical, reducing hospitalization rate by 26% and death rate by 80%. Unfortunately, seniors do not get help for over an hour after a fall in 20% of cases. There are medical alert systems, but many elderly individuals forget or prefer not to wear them and may be unable to call for help after a fall. An open-source, unobtrusive, wall-mounted system for fall detection was developed using a Raspberry Pi and Forward-Looking Infrared (FLIR) thermal camera. Thermal imaging preserves privacy while detecting heat signatures. The system uses an image segmentation algorithm and set of extracted thermal features to train a convolutional neural network to identify fallen individuals. Deep learning was used to analyze features due to its robust pattern recognition capability. The effects of factors including network architecture, number of training features, and body type were investigated. An accuracy of up to 99.4% with an average of 98.6% (SD 0.4%) was achieved even in the presence of nonhuman heat sources and pets. The system also demonstrated effectiveness on stairs with average accuracies above 96%. Image segmentation combined with measuring movement reduces false positives and allows the system to be pretrained and more robust for most room configurations. It has the potential to increase the safety and independence of elderly people living alone at home or in assisted living facilities, who are especially isolated during pandemics. The system can be reprogrammed for many monitoring applications, such as detecting if an autistic child wanders at night.

Awards Won:

American Statistical Association: Certificate of Honorable Mention

Patent and Trademark Office Society: Second Award of $500