Multi-subject Tracking by Vertical Pressure Signatures

Presented By Patrick Connor, PhD, PEng.

Research and Development Lead, Stepscan Technologies Inc.

Robustly tracking the continuous position, orientation, and basic posture of multiple people in a room is a challenging problem. Stepscan provides a new sensing technology to bear on this problem: a room-sized pressure sensing floor. Unlike computer vision tracking approaches, the view of each subject is rarely occluded because the subject is viewed via the pressure signatures (e.g. footprints) they leave behind. Pressure regions appear and disappear with movement, hence tracking becomes a problem of associating a time sequence of discrete pressure data to each individual present. To enhance Stepscan's robustness at simultaneous tracking of multiple subjects, they seek fresh solutions to this association problem in real-time and/or offline.

The **goal** is to track every individual's location and orientation from the time they enter to the time the exit the side of the sensing surface. Classifying posture is a secondary goal.

The **available data** include the pressure image for each time instant, the pressure image segmented into pressure regions, and ellipses fit to each pressure region to give position and orientation (simpler to work with than raw image information). The pressure image data indicate where pressure is being placed under the foot and can be used to watch for a shift in center of mass, even when feet are not moving.

The **challenges** include handling various postures and subject interactions. In general, most subjects will be standing, such that footprints make up the majority of pressure imprints. However, in some cases, subjects may stop and kneel or become prone (lay down), such that there may be more than two separate pressure regions associated with each individual at any moment. Also, footprints will sometimes be broken up into heel and forefoot areas. There are a variety of possible interactions between multiple subjects that a solution should be targeted to handle. For example: walking side by side, crossing paths, single file, turning, stopping and restarting, running, jumping, etc. In particular, tracking should correctly distinguish between individuals that converge and then diverge.

The **solutions** can target the real-time use case and/or the offline use case. Real-time solutions are allowed to be less robust but must be more efficient than offline solutions. Offline solutions have more data at their disposal (future footsteps in addition to current and past footsteps). Solutions to determining the orientation or posture classification may be considered separately. As an example, the current solution, which focuses on location tracking in the real-time use case, involves using a probability density function for each of several subject-distinguishing traits (e.g., proximity and movement direction) to compute probabilities of each pressure region belonging to each individual. Subsequently, each region is assigned to the individual with the highest associated probability. Individuals' x-y positions are computed as the center of pressure of all associated regions.

A Python setup with a dozen dataset scenarios will be made available to students for solution evaluation at the workshop. Students with an interest in localization, computational geometry, Bayesian modeling, Python, or machine learning will be well suited to contribute to this problem.