Int J Soc Robot (2010) 2: 1–2
DOI 10.1007/s12369-010-0044-0

Editorial

Kai O. Arras · Oscar Martinez Mozos

Published online: 30 January 2010

People detection and tracking is a key technology for social robotics and human-robot interaction, both growing research fields with many future applications. Social interaction with people, navigation in populated environments, recognition of human activities and intentions, tracking pedestrians in urban areas or detection of intruders are examples tasks that all rely on the ability to robustly detect and track humans.

Recent advances in estimation theory, data association, machine learning and sensor technologies have enabled us to design people detection and tracking systems with decent classification rates. However, there is a great demand for even more robust systems, especially over a wider range of conditions and from mobile platforms. There is also an increasing interest from industry for small-scale, low-priced yet robust people trackers to be employed in intelligent cars, surveillance systems or domestic robots.

This special issue appears as a follow-up to the workshop on People Detection and Tracking, held at the ICRA 2009 conference in Kobe, Japan. Some papers are extended versions of work presented in the workshop, others have been newly received. All papers went through a separate peer review process. The call attracted a great number of 27 submissions. Following the reviewer's recommendations, we selected those contributions that either break new ground with the approach, the sensor modality or the application.

K.O. Arras (✉)
Social Robotics Lab, University of Freiburg, Freiburg, Germany
e-mail: arras@informatik.uni-freiburg.de

O.M. Mozos
Robotics and Real-Time Group, University of Zaragoza, Zaragoza, Spain
e-mail: ommozos@unizar.es

The first two papers propose an extension of the Multi-Hypothesis Tracking approach to make it a recursive multi-hypothesis model selection machinery that hypothesizes jointly over both, multiple models (of different types) and observations-to-tracks assignments. The extensions have been independently developed, applied to different problems and presented at ICRA 2009. The two approaches differ in some mathematical details and it is a pleasure to see them here published in the same issue.

The first paper "People Tracking with UWB Radar Using a Multiple-Hypothesis Tracking of Clusters (MHTC) Method" by Sang Hyun Chang, Rangoli Sharan, Michael Wolf, Naoki Mitsumoto, and Joel W. Burdick addresses the problem of tracking multiple people using Ultra-Wideband (UWB) radar. This sensor is particularly suited in poor visibility conditions where vision and laser would fail. Return signals from targets have, however, a cluster-like nature due to multi-path scattering effects. For multi-target tracking, this poses a two-level data association problem in which clustering and observation-to-track associations have to be solved jointly which is done by the MHTC approach, developed by the authors.

In the second paper by Boris Lau, Kai O. Arras, and Wolfram Burgard entitled "Multi-Model Hypothesis Group Tracking and Group Size Estimation", the authors address the problem of tracking groups of people using laser data from a mobile platform. In addition to the unknown track-to-observation associations, the models hypothesize about track-to-group assignments during split, merge and continuation events. This is approached by their multi-model hypothesis extension of the MHT. The experiments demonstrate the system's ability to accurately track group formation processes and estimate the number of people in groups.

The paper "Multi-Part People Detection Using 2D Range Data" by Oscar Martinez Mozos, Ryo Kurazume, and Tsutomu Hasegawa also uses data from laser range finders and addresses the problem of detecting people by recognizing different body parts such as heads, upper bodies or legs. The final person detector is then composed of a probabilistic combination of the outputs from the individual body part classifiers. Experimental results with real data demonstrate the effectiveness of the approach to detect persons in indoor environments and its ability to deal with occlusions.

In the paper "Vision-Based System for Human Detection and Tracking in Indoor Environment" by Yannick Benezeth, Bruno Emile, Hélène Laurent, and Christophe Rosenberger, the authors propose a vision-based human detection and tracking system with the goal to limit the power consumption of buildings. The approach applies background subtraction to extract blobs that are later classified as people using multiple cascades of boosted classifiers. The method runs in about 10 fps on standard hardware and is well validated in different environments.

Simone Frintrop, Achim Königs, Frank Höller, and Dirk Schulz present in their paper "A Component-Based Approach to Visual Person Tracking from a Mobile Platform" a solution to the problem of people tracking using vision from a mobile platform. The paper proposes a component-based descriptor which is used as the observation model in a particle filter tracker. Several experiments carried out using a mobile robot show that this approach effectively tracks persons in indoor environments, outperforming related color-based tracking methods.

The work "Real-time Motion Tracking from a Mobile Robot" by Boyoon Jung, and Gaurav S. Sukhatme presents a real-time motion tracking approach for a monocular vision system on a mobile platform. Moving objects are identified as regions with locally consistent motion. They are tracked by an ensemble of particle filters, where each filter is responsible for tracking a single object. The resulting system can detect and track multiple independently moving objects in the camera's field of view. The approach is experimentally validated on several video sequences showing multiple moving objects under different types of ego-motion. In addition, the approach is demonstrated on several real robotic platforms.

There are two "application papers" that utilize people trackers for higher-level tasks, namely motion planning and human activity recognition.

The paper entitled "Probabilistic Autonomous Robot Navigation in Dynamic Environments with Human Motion Prediction" by Amalia F. Foka, and Panos E. Trahanias presents a POMDP approach to robot navigation in dynamic environments, where long-term predictions of human motion are made to improve the robot's planning and collision avoidance behavior. The predictions are based on destinations in the environment people have interest to visit. The paper presents a number of experiments with a real robot that illustrate the effectiveness of the approach and its capacity to plan paths that minimally affect motion of other dynamic objects.

In the paper "Tracking and Modeling of Human Activity using Laser Rangefinders" by Anand Panangadan, Maja Mataric, and Gaurav S. Sukhatme, data from a laser-based people tracker are used to recognize human activities. People trajectories are first segmented and clustered into short activity sequences, used to build a stochastic model of the observed motion patterns. The method then recognizes interaction between people by looking at how similar the distributions of their displacements are. This enables the robot to correctly recognize interacting people (e.g. ping-pong players) without pre-defined models of the interactions. The experiments with unscripted human activities demonstrate the viability of the approach in three different indoor and outdoor environments.

Finally, we would like to thank Editor in Chief Shuzhi Sam Ge and Assistant Editor John-John Cabibihan from the Editorial Board, and Gabriela Cisneros and Nathalie Jacobs from Springer for a great collaboration.

A special thanks to our reviewers for their support in maintaining the high standard of this issue: Ana Cristina Murillo, Anand Panangadan, Andreas Ess, Andrew Howard, Arturo Gil, Barbara Frank, Bastian Leibe, Ben Kröse, Bernt Schiele, Boris Lau, Diego Tipaldi, Dirk Hähnel, Dirk Schulz, Dizan Vasquez, Elin Anna Topp, Francisco Escolano, Fulvio Mastrogiovanni, Giorgio Grisetti, Haris Batzakis, Henrik Zender, Jorge Solis, Luciano Spinello, Matthias Luber, Monica Ballesta, Patric Jensfelt, Primo Zingaretti, Robin Murphy, Rudolph Triebel, Ryo Kurazume, Simone Frintrop, Siniša Slavnić, Tinne De Laet, Udo Frese, Xuan Song, Yannick Benezeth, and Yong Mao.