Seamless Identities and Knowledge Sharing in Multi-User Mixed Reality Spaces

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Abstract

Rich interaction scenarios in multi-user mixed reality (MR) environments demand accurate position tracking and identity management of individual persons. Where standard tracking solutions require the physical participants of the interaction scenario to wear RFID tags or comparable devices during the interaction, we propose a solution based on high-level knowledge sharing and multimodal data fusion with maximum freedom for the user. In this study we propose to use a high dimensional joint probabilistic data association (JPDA) method, not only for data association, fusion and position tracking, but also for sharing high-level knowledge for probabilistic identity management.

In MR spaces often different kinds of sensors are available, which could be utilized for tracking, enabling fault and noise tolerance. Nevertheless, simultaneous use of several sensor modalities inherently leads to the problem of data association and data fusion. Further, in many interaction scenarios, knowledge about the positions of individual physical entities are readily available, which can be used to modulate bottom-up sensory data. Inspired by top-down modulation mechanisms employed by the brain for solving the data association problem, we propose a probabilistic framework for position tracking and identity management, under consideration of the above mentioned facts.

In this work, we propose how the JPDA method, enhanced with Markov-Chain-Monte-Carlo algorithm for speed, can be made use of for sharing high-level knowledge contained in the interaction scenario for tracking purposes. We use a high dimensional state space to be able to distinguish individual identities. Different attributes of the individuals such as their position, sound, hue etc. are represented by single dimensions in the state space. As the system slowly acquires more and more knowledge about the individual participants of the MR space, their representation in this high-dimensional state space gets more and more separated from each other. Thus a seamless identity separation is achieved during the course of the interaction itself. By knowledge sharing we mean the use of high-level knowledge contained in the interaction scenario about the real individual participants. For example if possible future positions of individual real participants can be inferred from the scenario, it could be used to modulate the bottom-up sensory data. We show how this can be achieved using our probabilistic framework.

Multi-modal multi-target tracking is of major importance in many fields of research such as robotics, surveillance, navigation etc. Current technologies for tracking often do not exploit contextual knowledge for modulating bottom-up data. Our proposal for identity management and knowledge sharing could potentially be used in other application scenarios outside MR spaces. In future work, we intend to apply attention mechanisms to drive active sensors to gather specific information about the tracked objects or the environment. Such attentional knowledge complements other high-level knowledge and could be used to enhance tracking. Also attentive avatars or an attentive MR space adds for realism in virtual environments, and to bait real individual participants into specific interactions which would facilitate e.g. identity recovery.

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