Planning in Inhabited Environments

Human-Aware Task Planning and Activity Recognition

av

Marcello Cirillo

Akademisk avhandling

Avhandling för teknologie doktorsexamen i datavetenskap,
som enligt beslut av rektor kommer att försvaras offentligt
tisdagen den 14 december 2010 kl. 13.00,
Hörsal T, Örebro universitet

Opponent: Professor Dana Nau
Department of Computer Science
University of Maryland, MD, USA

Örebro universitet
Akademin för
naturvetenskap och teknik
701 82 ÖREBRO

Abstract

Promised some decades ago by researchers in artificial intelligence and robotics as an imminent breakthrough in our everyday lives, a robotic assistant that could work with us in our home and our workplace is a dream still far from being fulfilled. The work presented in this thesis aims at bringing this future vision a little closer to realization.

Here, we start from the assumption that an efficient robotic helper should not impose constraints on users' activities, but rather perform its tasks unobtrusively to fulfill its goals and to facilitate people in achieving their objectives. Also, the helper should be able to consider the outcome of possible future actions by the human users, to assess how those would affect the environment with respect to the agent's objectives, and to predict when its support will be needed.

In this thesis we address two highly interconnected problems that are essential for the cohabitation of people and service robots: robot task planning and human activity recognition.

First, we present human-aware planning, that is, our approach to robot high-level symbolic reasoning for plan generation. Human-aware planning can be applied in situations where there is a controllable agent, the robot, whose actions we can plan, and one or more uncontrollable agents, the human users, whose future actions we can only try to predict. In our approach, therefore, the knowledge of the users' current and future activities is an important prerequisite. We define human-aware as a new type of planning problem, we formalize the extensions needed by a classical planner to solve such a problem, and we present the implementation of a planner that satisfies all identified requirements.

In this thesis we explore also a second issue, which is a prerequisite to the first one: human activity monitoring in intelligent environments. We adopt a knowledge driven approach to activity recognition, whereby a constraint-based domain description is used to correlate sensor readings to human activities.

We validate our solutions to both human-aware planning and activity recognition both theoretically and experimentally, describing a number of explanatory examples and test runs in a real environment.