Distributed temporal event mapping and fusion

Diploma thesis

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Abstract

Localisation and mapping relies on the representation and recognition of features or patterns detected in sensor data. An important aspect is the temporal relation between observations in multiple sensor data streams. This thesis proposes a new approach for simultaneous localisation and mapping of temporal relations between observations.

Sensor data is interpreted as a sequence of events, where an event is the occurence of a distinguishable feature in the sensor data stream. The goal of this work is to develop a method for finding correlations between those events from different sensor modalities, which occur simultaneously or which are reproduceably in causal order.

A dynamical system is proposed to acquire correlations between simultaneous and sequential events from different sources, to map causal sequences considering absolute time spans, and to recognise previously observed patterns (localisation). The proposed method combines sensor modalities with different characteristics and timing behaviours, and is suitable for distributed computing. All sensor data streams are assigned to symmetric processes. For each sensor, mapping takes place locally in the assigned process. To achieve sensor fusion, all local maps are dynamically linked in realtime using direct inter-process communication. Mapping and localisation take place simultaneously in an infinite unsupervised distributed online learning process.

The dynamical system has been implemented as a distributed realtime system with symmetric processes. All processes communicate directly via remote procedure calls. They can be located on any computer connected to the robot's network. A realtime clustering network reduces the dimension of raw sensor data; cluster transitions are used as input for the dynamical system. Results from several physical experiments with different sensor configurations are presented.