Stage Oriented Design of an Intersection Management System Based on Laser Scanner Data

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November 20, 2015

Abstract

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1 Introduction

2 Stages Definition

In the designing of an IMS, there are four main stages that have to be performed from the data source to final output: preprocessing, feature analysis, pattern recognition and situation assessment. The aim of the first stage is to extract data of interest from the raw sensor information, using filtering and background subtraction techniques to get the foreground of the scene, remove noise and irrelevant data. Spatio-temporal alignment of data is also performed in this stage. In the second stage, the objective is to identify elements within the foreground and extract relevant features of them. The third stage receives the set of features from the previous stage and performs recognition and classification tasks. Also, tracking and prediction of objects' state is performed based on historic information. In the fourth stage, object behaviour and inter-objects interaction are analysed to identify context and detect situation or events of interest. This output could be delivered to an optional fifth stage of decision and control, to a human operator, or to a traffic agent or institution, to take immediate actions on traffic control, issue traffic tickets, warn drivers about possible incidents or improve transportation policies in a long-term basis. In figure 1, previously described stages are depicted, and also is shown how the data volume is reduced while data meaning increases in the last stages.

Different tasks could be performed in each aforementioned stages, as is referred in figure 2. Below there is a description of common concepts and methods associated with each of these tasks, some of them are sensor-independent and others are focused on a specific sensor or type of data. Additionally, these tasks could be used as fusion blocks for homogeneous or heterogeneous data.

2.1 Preprocessing

In the preprocessing stage raw data from sensor is received and the purpose is to enhance this data through filtering noise, removing outliers and discarding corrupted data. Also, in order to extract

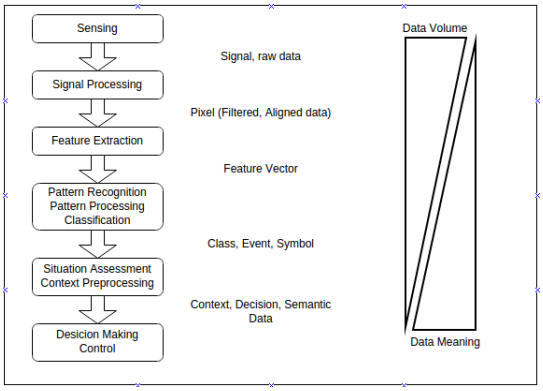

Figure 1: Dataflow through processing stages in an IMS.

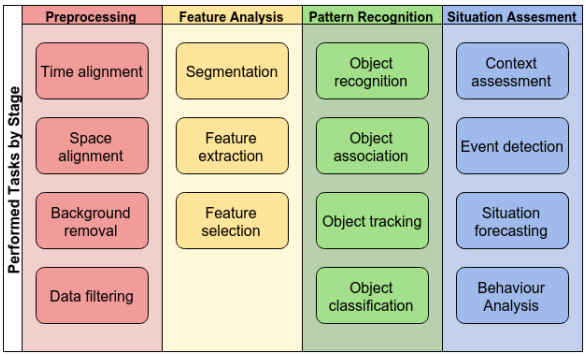

Figure 2: Processing stages and tasks performed.

meaningful data, background removal techniques are applied in this stage. For doing this, a background model should be generated. One typical approach to generate a background model is to use a threshold to determine if certain measure corresponds to background or foreground. This threshold is computed based on a peak value found in histogram information of the measure within a time window. Another approach consist in describe de data using a probability distribution function.

2.2 Feature Analysis

2.3 Pattern Recognition

2.4 Situation Assesment

3 Laser-based System Implementation

3.1 Dataset

The dataset used for this work was provided by POSS research group and was used for [1]. The dataset consist of ten minutes of laser scanner raw data from six sensors arranged horizontally over an intersection near Peking University. Background model and calibration data for each laser scanner is also provided. Additionally, dataset contains trajectory info of objects in the scene, generated by their algorithm.

3.2 Preprocessing

3.3 Feature Analysis

3.4 Pattern Recognition

3.5 Situation Assesment

4 Results

5 Conclusions and Future Work

References

[1] Huijing Zhao, Jinshi Cui, and Hongbin Zha. Sensing an Intersection Using a Network of Laser Scanners and Video Cameras. *IEEE Intelligent Transportation Systems Magazine*, pages 31–37, 2009.