Concept of a Framework for Moving Objects based on different Data Sources

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1 INTRODUCTION AND RELATED WORK

The knowledge of the location of humas, animals or objects is important to provide or derive information depending on this location. For example the location information is used to assist cognitive disabled people in their daily life (Patterson et al., 2004). New technologies to get the location have arised in recent years. Elephants in national parks are observed by the Global Positioning System (Slotow et al., 2000). In industrial or logistic companies paper wheels (Ukkonen et al., 2006) and staff are identified and tracked via Radio Frequency Identification (RFID) or Wireless LAN. Projects like Yamamoto model the indoor environment to locate and assist people (Stahl and Haupert, 2006).

Background: The idea of this framework is based on the tracking of laboratory mice in a semi natural environment via RFID, scale and webcam (Kritzler et al., 2008). That project investigates the influence of the environment to movement and behavior of mice in the case of Alzheimer's disease.

Aims: The aim of the proposed work is to generalize the first results concerning a scale-invariant tracking framework which is able to integrate movement data of heterogeneous sensor sources and to obtain information from different kinds of objects, animals and human beings where size, characteristics and environment (e.g. laboratory conditions or industrial environment) are irrelevant.

2 SCENARIOS

1. Tracking of Laboratory Mice: In the first scenario indoor tracking data of laboratory mice is collected via RFID and webcam. The weight data is gathered by a scale and stored in a relational database. The resolution in time and space is high. Furthermore a proprietary visualization of the mice movement and some rudimentary analyzes (e.g. meeting with other mice) of the data exist (Kritzler et al., 2007). Mice generate a huge amount of data in a short time. Limitations regarding privacy do not exist. The setup takes place in a small and controllable scale. The goal of this example for passive tracking is to gather information about the moving objects and to find patterns in movement and behavior.

2. Tracking of Service Engineers: The second scenario takes place in an industrial environment. Service engineers are tracked by different sensors beginning with a minimal instrumented environment (e.g. use of key stroke events) to a highly equipped tracking environment (e.g. use of Ultra wide band (UWB)). The location of a tracked person can be validated be the combination of two or more sensors (RFID tags have a fix position and can be compared with the measurment of UWB). The aim of this active tracking is to support these engineers by their maintenance work depending on the actual position (e.g. they get information how to repair a demaged component at the located position). The positional data is also used to localize technicans in case of an emergency.

3 Research Modules

Modeling of environment: A concept of a general three dimensional visualization of the modeled tracking environment is necessary. The model is the basis for the modeling of heterogeneous sensors and their positions. The required attributes for a scale invariant three dimensional modeling of sensors are determined. And they are used for the extension of a scene graph model with sensor nodes (using Virtual Reality Modeling Language and Java 3D). The detail of the model depends on the position of the tracked object. The positions of the different sensors can be changed, added or deleted. Besides the visualization, a categorization of the sensors with their different properties is also necessary.

Sensor Fusion: Various levels of instrumentation of the environment and the tracked objects / persons are considered. The framework will model different kinds of sensors sources and integrate them into the application. Data of sensors which are still integrated into in a scenario environment will be gathered, e.g. an electronic access control can be used as a positioning sensor (fix position of a door lock). Further examples are key loggers or the use of control elements / panels. The heterogeneous data sources and the gathered data will be handeled with a standardized data model (by using Sensor Markup Language). The generalized data model determinates which data is stored for positioning and tracking. In the case of universality the (semantic) data model must be easily extendible for more sensor sources which can be integrated later. On the one hand a useful data base schema for the storage of the data has to be designed. Information of the the tracked object´s location in time must be obtained. And on the other hand, interfaces with a semantic information model must be established because information are integrated and preceded on the basis of ontologies. It is considered to make use of existing ontologies as information basis which are extended by the requirements of the application domain. Furthermore a format has to be defined in which data are delivered for further analysis.

Learning: The combination of the different sensors is used to optimize the precision of the localization. Techniques like UWB are susceptible to interferences. But with static sensors like the invariant position of the RFID components a kind of uncertainty map can be established. Furthermore it is aimed to find patterns in movement and behaviour of the observed objects on a basis of a graph and to learn from their passed ways. By recognizing trajectories it will be possible to make predictions for future behavior.

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