Visual Interpretation of Motion by a Dynamic Space Time Grid Approach

Karl-Heinrich Anders and Radoslaw Rudnicki

Institute of Cartography and Geoinformatics, Leibniz University of Hannover,
Appelstr. 9a, 30167 Hannover, Germany
{karl-heinrich.anders, radoslaw.rudnicki }@ikg.uni-hannover.de

The interpretation of moving objects is an important issue in many disciplines, e.g. in biology, geography, criminal investigations (Anders, 2007), or geodesy, just to name a few. Observing moving objects can lead to insight in different scenarios. E.g. in biology it is interesting to observe animals and infer information about them by analyzing their collaborative behaviour (Laube and Imfeld, 2002). Observing the players of a football game can lead to conclusions about typical strategies in the collaboration of the players. However the automatic interpretation of moving objects is a hard to tackle problem especially if one has to handle large amount of data and no metadata is available.

We do not want to tackle the problem of observing the moving objects, which is a huge research area in its own (see e.g. Toth and Grejner-Brzezinska, 2005, Iwase and Saito, 2003), but we are assuming that the sensor data are available at certain instances in time. Furthermore, we are especially interested in groups of moving objects and their spatiotemporal behaviour. Thus, the research focuses on the identification of temporal patterns of group movements.

In an ongoing project we have to summarize the movement of pedestrians in inner city areas over different time periods (day, week, month, year) to estimate the dynamic pedestrian flow in inner cities. Our main goal is to represent the inner part of cities by a network flow and its dynamic behaviour over time. The problem is how to determine the directed graph with the edges and nodes of the pedestrian flow. In general a street map given in a graph structure is only sufficient for a small or mid scale analysis. In pedestrian areas there are larger areas, where pedestrians have the free choice to walk. Therefore for a large scale analysis the graph structure has to be derived from the observed trajectories of the pedestrians. We have to aggregate single trajectories and we have find the split- or merging-nodes for these aggregated trajectories.

In our approach we use the concept of finite elements, therefore we subdivide the observed area in a regular grid. For each grid cell we summarize the motion behaviour by counting the number of motion events and by computing the mean value of the direction and speed of all motion events over a certain time period. These mean values are displayed by appropriate symbols and colours. By changing the size of the grid cells one can analyse the motion behaviour on different scales. We think scale is an important factor for analysing spatiotemporal patterns, because patterns can have local or global characteristics. In moving pattern approaches like from (Gudmundsson, van Kreveld and Speckmann, 2007) one has to define a search radius, which can be interpreted like a scale parameter (a small radius is looking for local patterns and a large radius for global patterns). To find such a threshold automatically is a hard problem. We think offering a human operator the possibility to play around with such a parameter in a fast and intuitive way is the better approach to analyse such kind of data.

Beside the scale (resolution) factor the time of course is also very important in our approach. Some motion patterns can only be detected after a certain time period, which is in general unknown. This

is especially the fact for periodic or cyclic patterns. E. g. one or more pedestrians are walking around a church one or more times. One can describe this pattern only after the first cycle and not before, but a priori the period of this motion is unknown. Another question is from which time point we are interested in patterns. Our dynamic space time grid approach offers therefore the three parameters *where*, *when* and *how long*. "Where" is the local or global specification and can be interpreted as the scale or resolution. "When" is the start time from which one we are interested in patterns. "How long" is the duration of the time interval beginning at the defined start time. We will present first results of our approach, which will show that this interactive visual approach is a fast and scalable way to derive pedestrian flow networks from observed motion trajectories.

References

Anders, K.-H.: How to Visualise Space and Time in "modern" Maps?. In: Proc. of Joint Workshop Visualization and Exploration of Geospatial Data. ISPRS Archives Volume XXXVI - 4/W45, Stuttgart (Germany), June 27 - 29, (2007).

Gudmundsson, J., van Kreveld, M. & Speckmann B.: Efficient Detection of Patterns in 2D Trajectories. In: Geoinformatica, 11, Springer, 195-215 (2007).

Iwase, S. & Saito, H.: Tracking soccer players based on homography among multiple views. Visual Communications and Image Processing 2003. Edited by Ebrahimi, Touradj; Sikora, Thomas. Proceedings of the SPIE, Volume 5150, pp. 283-292 (2003).

Laube, P. & S. Imfeld, 2002: Analyzing relative motion within groups of trackable moving point objects. In: Egenhofer, M. & D. Mark (eds.), GIScience 2002, Boulder, CO, USA, LNCS 2478, Springer, 132-144.

Toth, C.K. & D. Grejner-Brzezinska, The Ohio State University, USA: Traffic Flow Estimation from Airborne Imaging Sensors: A Performance Analysis. In: ISPRS Workshop „High-Resolution Earth Imaging for Geospatial Information, Hannover, 2005.