TrackLab – An Innovative System for Location Sensing, Customer Flow Analysis and Persuasive Information Presentation

Abstract
TrackLab is a new tool for measurement, recognition and analysis of spatial behavior. Although a number of software packages have been developed which can, for instance, acquire tracking data or analyze that data, there is currently no one system which supports the entire workflow. TrackLab supports import from a wide variety of input formats, both real-time and offline. Furthermore a plug-in module is being developed which gives tracking data from a group of up to ten people on the basis of video images (that is, with no need for tags or similar). Once the location data is in the TrackLab software it can be visualized in a variety of ways and a statistical analysis report is generated. The analysis variables are based on established parameters for quantification of behavior based on location. The analysis helps you to gain insight into the spatial behavior of customers. For real-time applications of the system, the analysis variables can be used to control external software, for example presentation of information on a display when a person has followed a particular path through the shop.

Author Keywords
Tracking, Location, Customer flow, Dwell time, Retail, Behavior, Insight.

Andrew Spink
Noldus Information Technology bv
Nieuwe Kanaal 5
P.O. Box 268
6700 AG Wageningen
The Netherlands
Andrew.Spink@Noldus.nl

Nico van der Aa
Noldus Information Technology bv
Nieuwe Kanaal 5
P.O. Box 268
6700 AG Wageningen
The Netherlands
N.vanderaa@noldus.nl

Ben Locke
Noldus Information Technology bv
Nieuwe Kanaal 5
P.O. Box 268
6700 AG Wageningen
The Netherlands
Ben.Locke@Noldus.nl

Lucas Noldus
Noldus Information Technology bv
Nieuwe Kanaal 5
P.O. Box 268
6700 AG Wageningen
The Netherlands
Lucas.Noldus@Noldus.nl
ACM Classification Keywords
Tracking, Object recognition, Motion, Video analysis, Consumer products, Real time, psychology, Sociology.

Introduction
Traditional methods of obtaining information about the location of customers and the path they take through a shop such as annotation with pen and paper or event-logging software [e.g. 1] has the advantage of being straightforward to carry out, but has the disadvantage that it is both labor intensive and only delivers limited data. Furthermore, following customers in a shop can potentially influence their behavior and if the topic of the study is visible to the observers (for example advertising adjacent to a product), that might also influence the results (it is not a double-blind study). If customers can be followed with an automated tracking system then, after the initial investment, the running costs are much lower, and the data quality (both qualitative and quantitative) is much higher and it is completely impartial [2]. Timing information is more accurate, more people can be followed at once, and information such as the speed and path shape of the consumers (indicative of searching strategies) are uniquely available for accurate tracking data. Furthermore, an automated system gives the possibility to interact with the customers, for instance by sending a message to a smart phone app, or by displaying a graphic or PowerPoint image on a display unit dependent on the track followed by the person.

TrackLab
Noldus Information Technology bv [3] is a company that specializes in providing solutions for the measurement and analysis of behavior. It has recently developed a new product TrackLab [4], which is very suitable for analysis of behavior in the retail environment as well as other settings such as trade shows, open-air events, restaurants, etc.

Tracking technology
TrackLab is designed as a very open and flexible system, so that the software works with a wide variety of tracking technologies. It can be used with GPS systems for outdoor tracking, or in a retail environment where satellite reception is possible, for instance a shopping mall with a glass roof. TrackLab supports a wide variety of indoor tracking solutions, including Ubisense™ ultra-wideband sensors and tags [5], EagleEye™ stereo cameras [6], and Noldus’ video-based PeopleTracker™. For offline import of tracks, TrackLab support GPX, CSV and JSON formats. For live import of real-time data, TrackLab incorporates an import engine to enable it to be able to handle a wide variety of formats. The track data can also be edited to remove outliers, etc.

Spatial accuracy
The accuracy of the track data obtained depends on the tracking technology deployed and the physical setup. For instance with GPS data, in an open area it varies between 1 and 10 m but if some satellites are blocked by buildings, the accuracy will be reduced. Likewise, the Ubisense tags give an accuracy of better than 30 cm, but sufficient sensors must be placed so that a good signal is received throughout the store. TrackLab has special user-definable filters which can be used to reduce tracking errors and various data selection and editing possibilities to remove outliers.
PeopleTracker

There are a number of practical difficulties with most current tracking technologies in the retail environment. Many require the subjects to carry tags, Wi-Fi or Bluetooth enabled devices, or similar. That can be acceptable for controlled experiments, but is less suitable for tracking in a normal shop situation. EagleEye cameras are able to work on any subjects, and are scalable over larger areas, but they have the disadvantage of requiring specialized cameras.

PeopleTracker is a video-based technology which has the advantage of using input from normal video cameras to track several individuals, and is thus well suited to the retail environment. PeopleTracker is a vision-based analysis tool designed to extract the subjects’ positions for multiple calibrated side-view cameras with overlapping field-of-views [7]. The choice for side-view cameras instead of top-view cameras has been made since many applications include spaces with a low ceiling or no ceiling at all. PeopleTracker uses the multiple overlapping camera views to detect and track people in the 3D world automatically and non-intrusively. PeopleTracker uses proven computer vision techniques such as background subtraction to detect new subjects in the scene, voxel reconstruction to have a volumetric idea of where the subjects are in the 3D world, histogram comparison to distinguish appearances of different subjects and particle filtering to track the subjects efficiently [7]. The ground floor positions as output of the PeopleTracker can be used by TrackLab for track data analysis.

Track data analysis

TrackLab calculates a large number of statistics related to the location and movement of the subjects. The user can define zones (such as the location of a new product, the checkout area, etc) and the statistics are then calculated both for the entire track and for the individual zones. This enables calculations such as the dwell time in the region or a new product, the average speed in the checkout queue, which regions of the show the customers visit infrequently, and how much time the customers were standing still in the shop. Furthermore there are a number of statistics which can be used to quantify searching behavior of the customers, based on an analysis of the path shape of the customers. It is also possible to calculate group statistics across all the tracks in your study, for instance the average time that all the customers spent in the zone near to a new product.

Visualization of data

Although a quantification of the tracking data will often be necessary, in order to gain good insight into shoppers’ behavior a visual presentation of that data is often invaluable. TrackLab allows visual presentation of data in three different ways: the track plot, heat map, and a graph of speed.

The Track plot gives an overlay of all the tracks in your experiment on top of a floor plan of the shop. The software enables you to import a digital floor plan (in a bitmap format) and calibrate it so that it is the correct scale and position in relation to the tracks. You can pan and zoom the view, draw regions and points of interest (which are used in the analysis), and play the tracks back in a variety of ways.
Figure 1. Track plot visualization in TrackLab. The colored lines are subject tracks (user-defined style). Position markers show the location of the subjects at the current time during play-back. The shaded areas are user-defined zones. The scenario is a test to determine the best location for a new product, with the 4 zones indicating 4 possible locations of the product.

The heat map shows the difference in sample density for each location using different colors. Increased sample density is caused either by a subject spending longer at a given location, or by more subjects visiting the location during the recording. It is thus an excellent way to visualize interest in a region. For instance, if a new product (or an existing product with new packaging) is placed in several locations in a store, the heat map will illustrate how much interest there was in that product.

The speed of the subjects over time can also be visualized as a graph.
Figure 2. Heat map of tracks of customers in a store. The brighter the color, the greater the sample density. The visualization shows that customers spent more time by Product 6, and they also spent more time by the checkout, compared with the other locations.

This is useful information for determining both the interest in consumers in particular products as well as quantifying bottlenecks such as checkout queues.

**Interactivity and persuasive retailing**

It is also possible to configure TrackLab so that it provides input to other software, dependent on the path that the customers have taken in the shop or other behaviors such as standing still or walking fast. For instance, when a customer approaches a new product and pauses there, a signal can be sent to a PowerPoint presentation on an adjacent display, so that relevant information is shown, or a message could be shown on a smart phone app.

Figure 3. Graph of velocity of a subject moving over time. The cursor on the graph is synchronized with the position marker on the track visualization. You can see that the subject paused by Product 12.

**Case study**

During the workshop data from a simple case study will be presented illustrating the use of TrackLab in a simulated retail environment. This data is not yet available at the time of submission.
Conclusion
Recent developments in tracking technology have opened up new possibilities for obtaining valuable information about the behaviors of customers in retail environments. TrackLab software is a tool which can make those possibilities to the consumer research community, enabling further insights into customer decision-making and purchasing behavior.

Acknowledgements
The software presented in this paper was developed partly with funding from the following research projects:

- E-Track project (http://www.project-e-track.eu/) which is a European Union project carried out in the context of the Galileo FP7 R&D program supervised by the GSA (No. 277679-2).

- E-MOSION project (http://emosion-project.eu/) which is European Union project from the AAL Association and ZonMw (No. AAL-2011-4-141).

- GATE VidART project (http://gate.gameresearch.nl/index.php?pageID=18) supported by IOCTRegie, the Netherlands Organisation for Scientific Research (NWO) and SenterNovem.

References


