A Tool for Large-Scale Spatial Behavior Analysis in Indoor Environments

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Poster Abstract

Spatial behavior analysis in indoor environments is challenging: GPS is not available to track the location. Furthermore, analyzing the interaction of people with their environment goes beyond pure movement trajectories. Dalton et al. [1] developed "People Watcher", an iPad application for recording the path and spatial behavior of the observed participants. Since the recording is manual, applying it to simultaneous observation of groups or large-scale environment is challenging.

We present a sensor-based system (Figure 1) to automatically monitor the behavior of people in indoor environments such as museums, airports and other public spaces. Multiple sensors are distributed across the monitored space so that the sensors' range cover all areas of interest. A central system integrates separate measurements into a single spatial reference frame. The system supports different sensors: depth cameras (e.g., Kinect) can be used for a smaller range, recording also other aspects of spatial interaction such as the skeleton of the body and the position of the hip, feet, and the head. This can be used to detect and interpret the person's pose and their viewing direction. Based on the unique features of the skeletal and the facial coordinates, the system can re-identify visitors after they temporarily walk outside the area covered by the system. LIDAR sensors having larger range are also supported, but only for recording spatial movement. The system also allows for recording several people simultaneously over time making it possible to analyse group interactions (Figure 2).

adfa, p. 1, 2011.

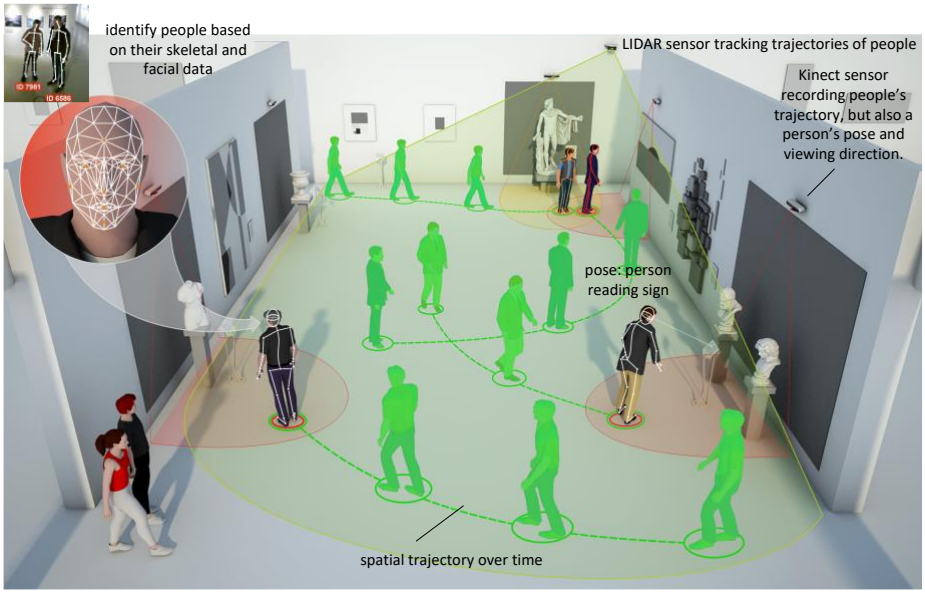

Fig.1 Recordings of sensors in an indoor environment.

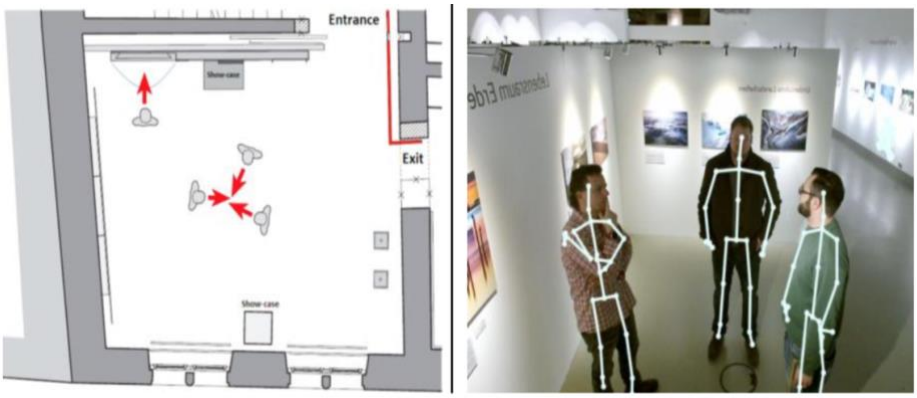

Fig.2 Group interaction.

The system (Figure 3) has been tested for in the Horse Museum in Münster, Germany. After the set-up, it recorded data of visitors for 60 days without interruption. We also conducted controlled tests to investigate the reliability of the data:

- People are localized with the accuracy of 3-10 cm.
- The viewing direction is determined with the accuracy of 20-100 cm, depending on the distance and the angle of the observer.
- Recognition of people in the frontal position equaled 80%. This can be improved by recording additional data about the visitors. Currently, due to privacy concerns, we limited the recording to core skeletal and key facial points.

Within Bitgod's attention model [2] of museum visitors, we can automatically identify the following events:

- Approach: trajectory entering a certain region in front of the exhibit, slowing down;
- Stop: Speed slowing down up to complete stop for a certain time;
- Look At: Location within the zone in front of the exhibit and viewing direction toward the exhibit;
- Focus on: Looking toward the exhibit for a certain time.

Future work involves identifying a broader range of actions, such as reading labels, and interactions between visitors.

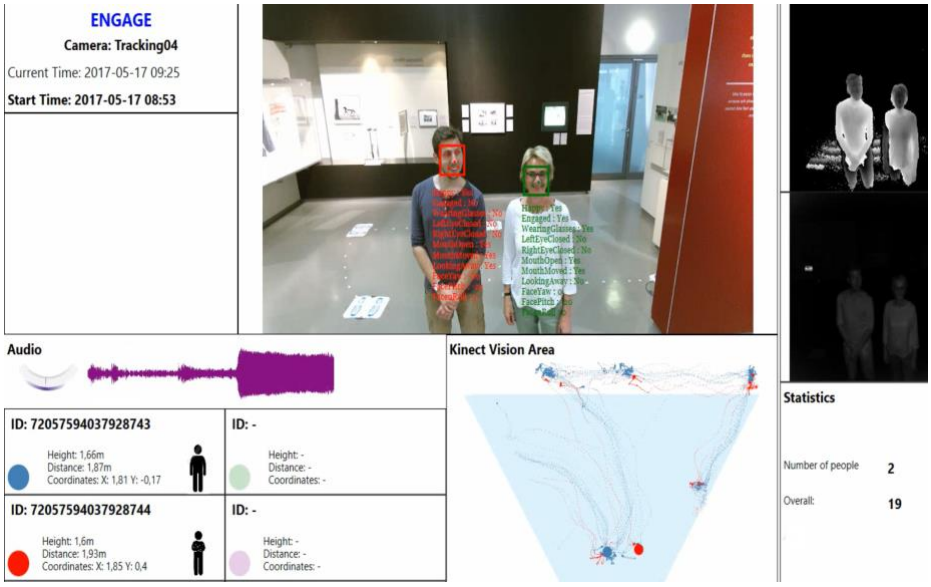

Fig.3 Screenshot of the tool's interface.

References

1. Dalton, N. S., Conroy Dalton, R., Hölscher, C., & Kuhnmünch, G. (2012). An iPad app for recording movement paths and associated spatial behaviors. In C. Stachniss, K. Schill, & D. Uttal (Eds.), Spatial Cognition VIII (pp. 431–450). Berlin Heidelberg: Springer.
2. Bitgood, S. (2010): An Attention-Value Model of Museum Visitors, Report, Jacksonville State University.