Measuring Human Movement Patterns and Behaviors in Public Spaces
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Measuring Human Movement Patterns and Behaviors in Public Spaces

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Introduction

Cities require reliable data on pedestrian movement and behaviors to evaluate the use of public spaces. Studies of such micro scale movement behaviors are challenging as they demand accurate and simultaneous tracking data for several individuals who may move close together, and where the movement of each individual depends upon interactions with others as well as on the physical layout of the place and actors in the space traversed.

To collect and analyze data for such studies, we propose a system using thermal cameras and Computer Vision (CV) technology combined with the analytical virtues of Geographical Information Systems (GIS) to track and assess pedestrian dynamics and behaviors of the everyday movement patterns and situations occurring in urban streets and plazas.

Method

Our method enables recording of georeferenced positions of individuals in a scene 30 times per second. By using a homography matrix to transform between image and real world coordinates the spatial accuracy of the tracking is about 25-100 cm depending on people’s position in the camera’s field of view (FoV). This allows for the analysis of behavior and attendance at a fine scale compared to other methods for pedestrian behavior monitoring [1,2].

The use of thermal cameras has the advantage over normal cameras that they can operate independently of light, and in many situations they perform better with Computer Vision software as segmentation of moving objects is easier in thermal videos (see table). At the same time concerns for privacy issues when tracking people can be neglected since the cameras literally just record the temperature of the city life with no risk of revealing individuals identity from the video stream. Thus the technique ensures privacy by design and is legal to apply.

Furthermore the prices of thermal cameras continue to be lowered at the same time as the resolution keeps improving [3].

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal camera</td>
<td></td>
</tr>
<tr>
<td>Easier segregation</td>
<td>Re-identification difficult</td>
</tr>
<tr>
<td>Independent of light</td>
<td></td>
</tr>
<tr>
<td>No privacy issue</td>
<td></td>
</tr>
<tr>
<td>High resolution</td>
<td></td>
</tr>
<tr>
<td>RGB camera</td>
<td></td>
</tr>
<tr>
<td>Re-identification possible</td>
<td></td>
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<tr>
<td>Cheap Sensors</td>
<td></td>
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<tr>
<td>High Resolution</td>
<td></td>
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<td></td>
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</table>

Table: The table describes the pros and cons in relation to using thermal cameras vs. normal RGB camera for Computer Vision tracking of people in outdoor urban scenes

This add to the practical applicability of thermal sensors for pedestrian behavioral studies. Our method builds on previous CV work by [4,5].

Pilot study in Copenhagen

In June 2013 we conducted a pilot study at the Kulturvægten plaza in Copenhagen which is a pedestrian zone with a continuous flow of pedestrians from several directions that need to negotiate each other. A single state-of-the-art uncooled thermal camera with a resolution of 640x480 pixels (Axio T122), a lens with a focal length of 10 mm, a viewing angle of 57°, and a 30 fps camera frame rate was used. Background subtraction was applied to detect people. To assess the quality of the trajectories generated by the CV software, Ground Truth (GT) trajectories were digitized manually for all individuals passing or residing in the scene in the five minutes of video analyzed. The manual digitization was done in the Target software developed at Lund University [6].

Analysis of behaviors

Tracks of people walking alone or in social groups of different sizes were recorded, as well as people waiting, people having a conversation, and people dragging their bikes or pushing prams, wheelchairs. While going through the videos to digitize the GT tracks we have identified characteristic movement behaviors such as meeting, flocking, avoiding, and following a leader [7]. Interesting individual movement patterns were also found. An example of this is a ‘floor’ working for a charity organization attempting to stop people in the street to recruit them. The behavior of the faker and the people he approaches is used here to show the extraction of tracks for individual’s behaviors.

Outlook and perspectives

Based on the data and experiences gained from the pilot study we are preparing a full scale experiment using multiple thermal cameras with overlapping FoVs to be carried out over a sustained period of time.

The study is to be combined with sampled periods where qualitative data from human observations on the street level will be collected as well. Further research will be to develop advanced methods in GIS to enable extraction of behavioral parameters for different classes of tracks that can be used to calibrate models of pedestrian movement.

Our approach to tracking urban public life should be seen as a supplement to the traditional qualitative and intuitive manual methods for data collection used in studies of urban public spaces and qualities [8,9]. It is the aim that our work can contribute to the development of new digital methods in this field.

References

5. Poulsen, E. S. et al. (2012) Controlling Urban Lighting by Human Motion Patterns Results from a Full Scale Experiment. In ACM International Conference on Multimedia (MM).

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The authors would like to thank Dr. Michael Laureshyn from Lund University for permission to use the T-Analyzer software and assistance with setting it up. We would also like to thank the company Fokustransektorn for allowing access to their roof top terrace for us to install the thermal camera for the pilot study.

Video visualizations

http://youtu.be/kNhCYP6Peg
http://youtu.be/1qD7FWmHz

1. The faker is talking to a person
2. End of conversation and split up
3. Approaches person successfully
4. End of conversation and split up
5. Approach unsuccessful
6. Thes new approach but unlucky
7. Thes new approach again
8. Approach unsuccessful
9. Decides to take a break